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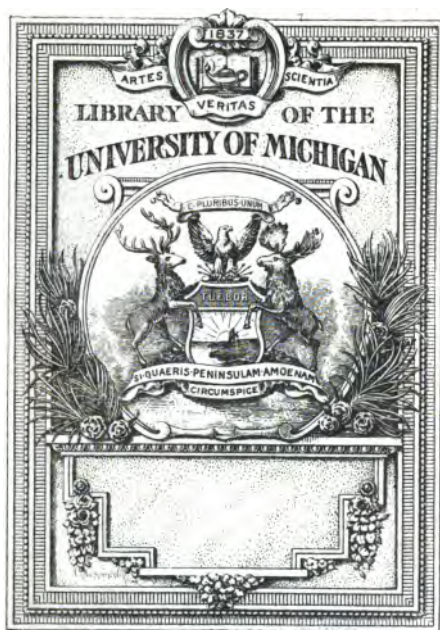
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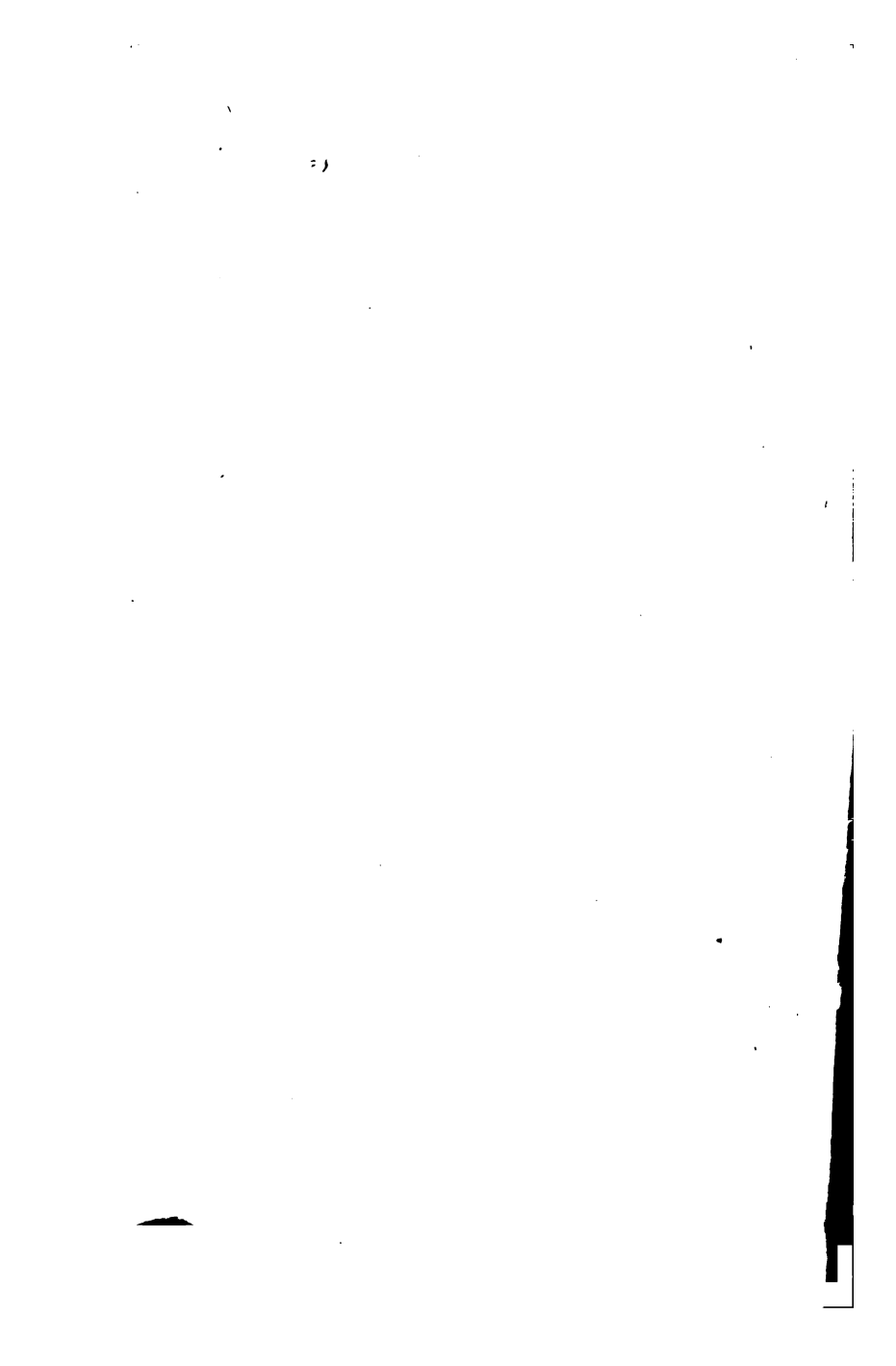
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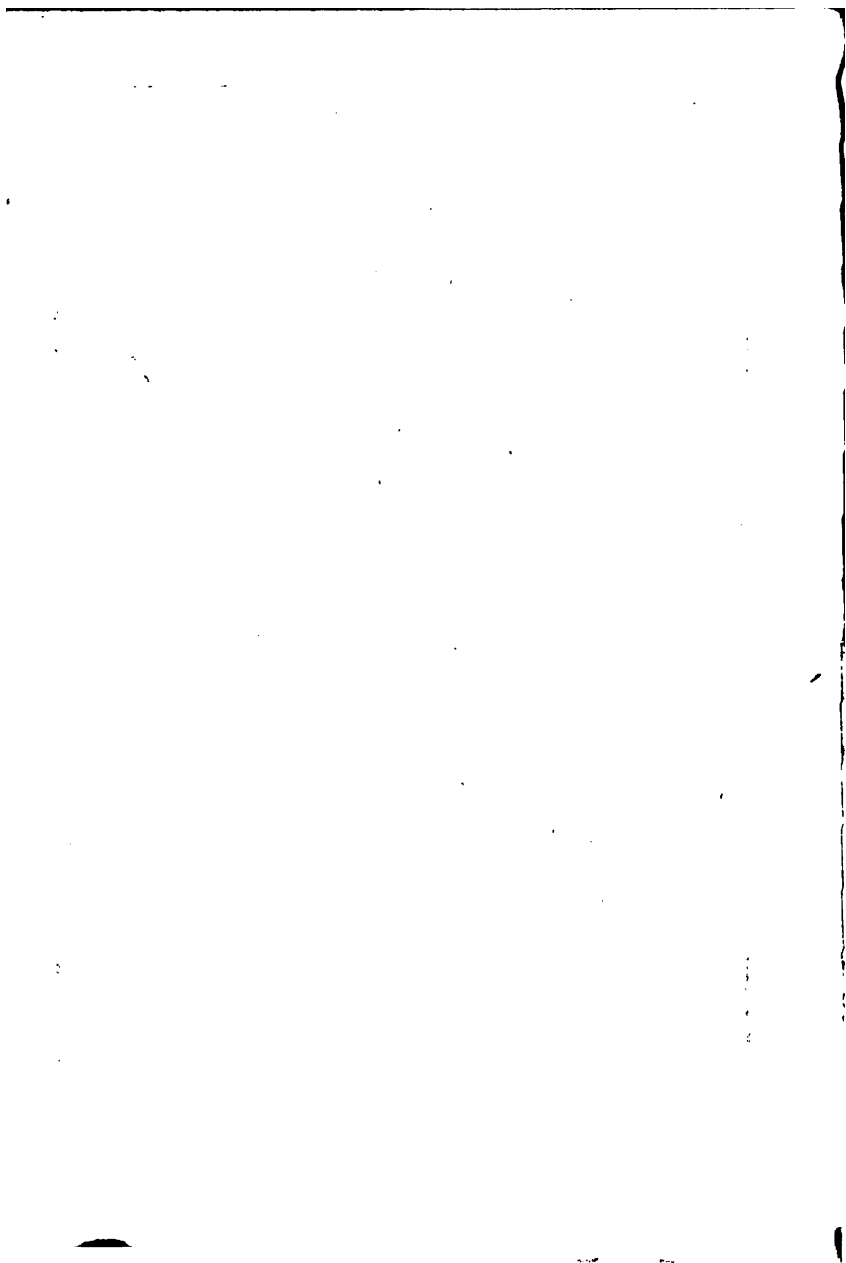
TECHNOLOGICAL HANDBOOKS.

EDITED BY H. TRUEMAN WOOD,

Secretary of the Society of Arts.

DYEING AND TISSUE-PRINTING.

BY W. CROOKES, F.R.S.



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TECHNOLOGICAL HANDBOOKS.

DYEING AND TISSUE-PRINTING.

BY

W. CROOKES, F.R.S.

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PREFACE.

THIS work on dyeing and tissue-printing has been prepared with special reference to the needs of students preparing for the technological examinations of the City and Guilds Institute. It is of necessity brief, and its object is more to exhibit the general principles of the arts in their practical working than to enter into all their almost endless *minutiae*. An attempt has been made to give the leading features of each department of dyeing, as modified by the kind of fibre operated upon, and by its condition, whether in the raw state as yarn, or as cloth. The uses of the various colouring matters, mordants, &c., are shown in practical examples, and special attention has been paid to the recently discovered artificial colours which have so remarkably extended, and at the same time simplified and rationalized the tinctorial arts.

As regards printing, the author has sought to describe the various styles, the accessory operations, and the machinery employed.

It is not for a moment presumed that the most careful study of this book will make any man a dyer or a printer. But it is hoped that the student will be able to obtain from it a general knowledge of the objects, the conditions, and the resources of the tinctorial arts, so that

when taking part in actual work, whether on a merely experimental or a commercial scale, he may understand what he is doing, why he is doing it, and what are the properties of the agents in his hands.

It is desirable that the student before taking up this book should have some knowledge of the elements of chemistry. Theoretical reflections have been, however, avoided as much as possible.

The technical language of dye, print, and chemical works has been employed in preference to that of strictly scientific circles. These terms have in all cases been explained.

The weights and measures used in the receipts are those customary in England, viz., the avoirdupois standard for all larger quantities, and for very small weights Troy grains, of which $437\frac{1}{2} = 1$ oz. avoirdupois.

For liquid measures, quantities below a pint are often expressed in fluid ounces, of which $20 = 1$ pint. In dye-works, &c., measures frequently used are the gill, which in the manufacturing districts is $\frac{1}{2}$ pint, = 10 fluid ozs., and the noggin, $\frac{1}{4}$ pint, = 5 fluid ozs.

In some receipts the quantities of water, saline solutions, extracts of dye-woods, &c., are measured by the pail or "burn," which may hold about 2 gallons. Smaller quantities are often measured by the "piggin," a small wooden measure, holding about $1\frac{1}{2}$ pint. The pail (French *sceau*, German *eimer*) and the piggin are not legal measures made exactly to one standard, nor are they in use always filled up to a certain line.

Specific gravity—a very important consideration for acids, dilutions of mordants, extracts of dye-wares, &c.—is expressed in this manual in Twaddell's scale, as commonly used in manufacturing establishments. On this scale the specific gravity of water = 0. It is readily converted into direct specific gravity by the following simple calculation. To convert Twaddell into direct specific gravity multiply by 5, considering the product as decimals, and add to it

1·000. Thus if a sample of oil of vitriol marks 168° = Tw., we have—

$$\begin{array}{r} 168 \\ 5 \\ \hline \cdot 840 \\ 1\cdot 000 \\ \hline \end{array}$$

1·840 the direct specific gravity.

On the other hand, if the strength of a liquid has been taken by direct specific gravity we find the corresponding degree Twaddell by subtracting 1·000, and dividing the remainder by 5.

Thus, if the direct specific gravity of a sample of muriatic acid be 1·160, then—

$$\begin{array}{r} 1\cdot 160 \\ 1\cdot 000 \\ \hline 5)160 \\ \hline \end{array}$$

32°, the degree Twaddell.

Beaume's scale, persistently used on the Continent, cannot be recommended, as it bears no simple relation either to direct specific gravity or to Twaddell.

For indicating degrees of heat the ordinary scale—Fahrenheit's—has been used. At the same time it must be confessed, that the Centigrade scale used in France, which puts the freezing-point of water = 0, and the boiling-point = 100°, is much simpler.

To convert Centigrade into Fahrenheit, if the temperature be above the freezing-point of water (and lower temperatures do not occur in dyeing processes), multiply by 9, divide the product by 5, and add 32 to the quotient.

To convert degrees of Fahrenheit above the freezing-point, subtract 32, multiply the remainder by 5, and divide the product by 9.

In German dyeing receipts the temperature is often expressed in degrees of Reaumur—freezing-point = 0, and boiling-point = 80.

To convert Reaumur into Fahrenheit, multiply by 9, divide by 4, and add 32 to the quotient.

To convert Fahrenheit into Reaumur, subtract 32, multiply the remainder by 4, and divide the product by 9.

Among the works which have been consulted in preparing this manual the principal are:—

Periodicals: "Chemical News," "Chemical Review," "Textile Colourist" (Manchester), "Textile Colourist" (Philadelphia), "Bulletin de la Société Industrielle de Mulhouse," "Bulletin de la Société Industrielle de Rouen," "Moniteur Scientifique Quesneville," "Bulletin de la Société Chimique de Paris," "Le Textil de Lyon," "Moniteur de la Teinture," "Teinturier Pratique," Dingler's "Polytechnische Journal," Reimann's "Faerber Zeitung," "Deutsche Faerber Zeitung," "Leipziger Muster Zeitung," &c.

Independent Works: "Dyeing and Calico Printing," by Dr. F. Crace-Calvert; "Handbook of Dyeing and Calico Printing," by W. Crookes; M. D. Koeppelin on "Silk Printing;" "Dyeing, Printing, and Bleaching," by Michel de Vinant; Articles on dyeing and printing in Ure's "Dictionary of Arts, Manufactures, and Mines;" do. in Muspratt's "Dictionary of Chemistry;" J. W. Slater's "Manual of Colours and Dye Wares;" Smith's "Practical Dyer's Guide;" Spon's "Encyclopædia of Industrial Arts" (for bleaching); Moyret, "Traité de la Teinture des Soies;" J. Persoz, "Traité de l'Impression;" E. C. Haserick, "Secrets of Dyeing Wool, Cotton, and Linen;" J. Jocquet, "Woll und Seidendruckerei;" F. Springmühl, "Lexicon der Farbwaaren;" C. O'Neill, "Calico Printing, Bleaching, and Dyeing;" A. Spirk, "Praktisches Handbuch der Faerbererei," &c., besides the specifications of patents and the instructions issued by the manufacturers of new colours.

W. C.

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DYEING AND TISSUE-PRINTING.

GENERAL INTRODUCTION.

THE tinctorial arts, in the widest sense of the term, include the production of colour on organic fibres and surfaces of the most varied kinds—silk, hair, wool, leather, fur, feathers, bone, ivory, horn, wood, cotton, flax, jute, hemp, paper, &c.,—whether in their original condition, or after having undergone some manufacturing process. Where the object in view is to obtain one uniform colour over the entire surface, the process is called staining, if the material taken in hand is wood, bone, ivory, or paper; and it is called dyeing if the substance is a fibre capable of being spun or woven, or the threads or tissues obtained from such fibres. These distinctions, however, are not very closely observed, and have no better basis than custom.

In dyeing, properly so called, the article to be dyed is immersed for a longer or a shorter time in a liquid holding certain colouring matters in solution, or at least in very fine suspension. The liquid employed in practice is, so far, always water, on account of its cheapness and general applicability. Proposals, however, have lately been made to dye in baths of volatile mineral oils, or even to dispense with solvents altogether, and to apply the colours in a dry state. Whether any such innovations will afford substantial advantages, or be able to establish themselves on the industrial scale, is quite an open question.

The first step to be taken in all the tinctorial arts is

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to secure perfect cleanliness of the articles to be coloured, technically spoken of as the "goods." This is necessary, because dirt of various kinds, especially grease, may prevent the colours from attaching themselves to the fibre, and, further, because it may greatly interfere with the behaviour of such colours, modifying the shade to be produced. Hence the first step is a very careful washing with soap-lye, hot or cold, or with or without the addition of soda crystals, ammonia, &c., according to the nature of the fibre or tissue. As a rule such washing is followed up by a thorough rinsing in clear water, until no trace of soap, soda, &c., remains in the goods. Soap is, indeed, a useful agent in fixing certain colours; but in such cases it is specially applied in known quantities. Where it is not thus specially needed, it is inconvenient or hurtful, and must be carefully avoided. These preliminary cleansing operations are generally performed before the goods come into the hands of the dyer, properly so-called, but he should satisfy himself that the work has been thoroughly performed. Neglect in this respect often gives rise to serious and apparently inexplicable failures in later stages of the process. The dirt to be removed may consist of extraneous matter which has come in contact with the goods in the raw state, or of materials purposely or accidentally applied during the operations of spinning and weaving, such as grease, size, paste, iron rust, &c.; very troublesome spots are often occasioned by tobacco-juice. Weavers sometimes contract the habit of chewing tobacco, and spit upon the web in the loom. As the juice of tobacco contains, besides colouring matter, a proportion of tannin, the spots upon which such juice has fallen will, after dyeing, appear distinctly darker than the rest of the piece.

It will even here be apparent that an unlimited supply of pure water is the first consideration in selecting a site for dye or print works. Instructions for judging of the quality of water will be given afterwards.

A point which should at the very outset be impressed upon the mind of the learner is the necessity for absolute cleanliness, or, as it is sometimes called, "chemical purity." Neither in the vessels or other plant used, in the water, in the goods to be dyed, nor in the colouring matters, &c., brought into play, should there be any substance which is not intended and taken into account in the result expected. Where this rule is not observed as far as it is humanly possible, success and failure are both matters of chance. How little of an unexpected and undesired substance may interfere with the colours to be produced, it would be unsafe to say. But alizarine reds, *e.g.*, may be deprived of somewhat of their brightness and beauty by proportions of iron incalculably small.

But let us suppose that all foreign matter, all external impurity, is removed from the goods, there are still substances which make up part and parcel of the fibre in its natural state, and which require to be expelled. These are certain colouring matters. Silk as spun by the silkworm, cotton as picked from the pod, and wool as cut from the sheep contain natural dyes incapable of removal by any mere cleaning, and which would be very much in the way of the dyer, who requires, except for blacks, dark browns, olives, &c., to begin his operations upon a perfectly white material.

The removal of these natural colours is bleaching, which is as much needed for goods that are to be dyed or printed as for those used in the white state. Indeed, calico which is to receive alizarine (madder) colours is more carefully bleached than such as is sold undyed. The reason of this is two-fold. Any residue of the original colour of the fibre must modify and interfere with the shade applied by the dyer. Suppose a raw material with a yellowish tint, the most beautiful violet dyed upon it would verge slightly to a brown; a slight blue shade would, in like manner, spoil scarlets. On the other hand, the more purely white any surface, the

more light it reflects. Now, as the dyes generally used, especially in light shades, are not perfectly opaque, they appear more brilliant if applied upon a white surface, being lighted up by the rays reflected from the white matter below. From these considerations it will appear that a grade of bleaching which might pass muster for white goods will be found imperfect, if brilliant colours are applied to the yarn or cloth.

The processes for bleaching vary with the nature of the fibre. Wool is bleached by the action of the fumes of burning sulphur (sulphurous acid gas, or, in more modern language, sulphurous anhydride). This process is generally known as "stoving." A preferable method is treatment with a solution of the bisulphite of soda, to which a little muriatic acid is added to liberate the sulphurous acid, which is the decolouring agent. Others, instead of adding the acid to the solution of bisulphite of soda, pass the wool, or woollen yarns, &c., through muriatic "sour," *i.e.*, muriatic acid let down with water to 2° Tw.¹ The first method has the advantage that all the sulphurous acid is utilized; but, in the second method, the sulphurous acid is liberated within the fibre, and thus acts more perfectly. It must be mentioned that a very considerable portion of the wool worked up, *i.e.*, all that which is dyed to dark colours, does not undergo any bleaching at all.

Silk is bleached very much on the same principle as wool, preceded by boiling with soap.

Of late very successful use has been made in silk bleaching of the peroxide of hydrogen (hydric peroxide or oxygenated water). This treatment is particularly advantageous for the so-called "Tussah," "Tusser," or wild silks. Should peroxide of hydrogen, or the materials for its production, ever become cheaper, there is little doubt but that it will become a formidable rival to chlorine in bleaching the vegetable fibres.

¹ *i.e.* 2 degrees of Twaddell's hydrometer, sometimes also called Twaddle's.

Cotton, linen, &c., were formerly bleached by means of treatment with so-called "lye," i.e. a weak solution of carbonate of potash, made by extracting wood-ashes in water, and using the clear liquid. They were then exposed to air, light, and moisture by being spread out in the bleaching grounds (grass-lands reserved for this purpose), and turned and watered in case of dry weather. This process is to a great extent superseded since the introduction of chloride of lime. It still, however, maintains a place in linen bleaching, as the best practical authorities find that it cannot be advantageously laid aside.

We shall now describe the operations of cotton bleaching in some detail.

Bleaching Cotton.

Cotton, unlike wool, is never bleached in an unmanufactured condition, but always either as yarn or as cloth. Consequently, over and above its natural impurities, it will contain all the substances which have been intentionally added to it or which it has accidentally taken up during the processes of spinning and weaving.

By natural impurities we understand everything present in the fibre except cellulose, that is to say, cotton-wax, a small quantity of margaric acid, pectic acid, albuminous matter, and two colouring principles, the one readily and the other sparingly soluble in alcohol. The total weight of these impurities does not exceed one-half per cent., but as unmanufactured cotton loses about 5 per cent. in bleaching, Dr. Schunck, who has carefully examined this subject, concludes that some other substance is present which has escaped detection, and which is probably parapectic acid.

The artificial impurities—accidental or intentional—may amount in woven goods to 30 per cent., but in yarns are much less. They consist of grease, starch, and all the various ingredients of sizing, besides oil from the machinery. The removal of all these impurities, so that

nothing but pure white vegetable fibre may remain, is the result sought in the highest grade of bleaching—technically known as madder-bleach—because it was first applied to goods to be printed with madder colours. It is also used for all yarns and cloths which are to receive light and pure colours. For blacks, dark shades, and for goods which are to remain white, a less thorough treatment is adopted.

The first step, with piece goods, is stamping, in order to distinguish the various lots of cloth. For this purpose letters or figures are marked at one end of each piece with some composition capable of resisting the bleaching operations—gas-tar, sometimes thinned with turpentine or light petroleum oil.

After thus marking, the pieces are stitched together, end to end, in lots of five. This is generally done by means of machinery, which it does not fall within our province to describe.

The next step is singeing. All the fine loose down which stands up on end on the cloth has to be removed before pieces can be advantageously bleached, printed, and, in case of stuffs, &c., dyed. This is done by passing the goods rapidly over revolving hot cylinders, over hot plates, or through the flame of gas; the latter method is now generally preferred. The cloth passes at the rate of about 5,000 yards per hour through a range of jets in which gas is burnt, mixed with such a proportion of common air that the combustion is perfect, and no soot or smoke is produced. Probably the most satisfactory singeing apparatus is that of Messrs. Mather and Platt. One pound of coal, converted into gas, singes from 70 to 80 yards of cotton cloth.

After singeing, the pieces are washed, folded up as they come from the washing machine, and allowed to lie in a heap over night.

The next step is the so-called limeing process, *i.e.* a passage through milk of lime, from which the pieces pass at once into the kiers. These are vessels of stout iron

plates, generally arranged in pairs, and fitted with a false bottom, upon which the pieces are laid. This false bottom is either a cast-iron grating or a heap of smooth river stones. The arrangement of the steam-pipes, taps, &c., cannot be easily explained without the use of diagrams and models. In these kiers the goods are boiled by the admission of high-pressure steam, washed, and again laid in a pile on the floor of the bleach-house.

Next follows souring, known as the "lime-sour," or "grey-sour." The "sours" consist of dilute muriatic acid at 2° Tw., through which the pieces travel at a uniform rate. After souring every trace of acid must be entirely removed. For this purpose the cloth runs in succession through two washing machines, and passes thence into the kiers to be boiled with a resin-soap. The usual proportions for this process, which is called the resin-boil and ley-boil, are, to 12,000 lbs. cloth, 770 lbs. soda-ash, 214 lbs. resin, and 1,400 gallons of boiling water. The kiers are worked at a pressure of 40 to 50 lbs. for seven hours. If low-pressure kiers are used with from 8 to 10 lbs. of steam, the boiling is kept up about twelve hours. With the most recent improved kiers (injectors), three to four hours at a pressure of 50 lbs. is sufficient.

After the resin-liquor has been expelled, a solution of soda-ash, preferably free from caustic, is run in, in the proportion of 120 lbs. soda-ash to 1,400 gallons water for the same weight of goods. Boiling is then resumed for a couple of hours, the soda-ash liquor is run off, and the pieces washed immediately.

The object of this boiling is to remove all traces of resin-soap and of unconverted resin which may remain among the goods. It is important to see that the resin has been duly boiled with the alkali before its introduction into the kier. For this purpose some bleachers heat to a boil 33 gallons soda-lye at 70° Tw., with an equal bulk of water, add then 220 lbs. broken resin, stir for fifteen minutes, and boil for six hours, or till the resin is perfectly dissolved.

The resin soap as above given requires the addition of the solution of 450 lbs. soda-ash for the 12,000 lbs. cotton.

The washing after the resin-boil and its supplementary ley-boil must take place without delay, as iron-mould may result if the pieces are left in the kier after the lye has drained away.

The next step is the treatment with chloride of lime, or, as it is technically called, "chemicking." The bulk of the impurities being removed, what is next wanted is to whiten. For this purpose the pieces are made to travel through a so-called chemicking machine which is supplied with a clear solution of bleaching-powder at from $\frac{1}{4}$ to $\frac{1}{2}^{\circ}$ Tw.

The chemicking process requires the careful observance of certain particulars. The liquid is generally applied cold, and it is safer to give repeated passages through a weak liquor, rather than one through a strong solution, which may, and probably will, tender the cloth. The liquid must be quite clear, and free from undissolved floating particles which, if they come in contact with the cloth, are liable to make holes. Chlorides of soda, potash, and magnesia may be used if it should be desirable on any special account.

It must be understood that if the chloride of lime were used at an earlier part of the process before the oily and fatty impurities had been removed, instead of whitening it would produce stains almost impossible to remove. The more skilfully and carefully the treatment with the lime, the soap, and the soda-ash has been conducted, the less work remains for the chloride of lime to do—a very desirable matter.

As samples of chloride of lime vary greatly in strength, and as the solutions change on exposure to the air, the mere strength as shown by the Twaddell is not sufficient, and a special test is needed, which is here briefly described as generally used.

The following standard tests are kept ready:—Arsenic

solution, made by dissolving $3\frac{1}{2}$ grains white arsenic in 1 quart soda-lye at 16° Tw. at a boil, and preserving the cold liquor.

An indigo solution is next prepared by mixing one measure extract of indigo, $2\frac{1}{2}$ measures sulphuric acid at 144° Tw., and $5\frac{1}{2}$ measures of water. The whole is then stirred up well together, filtered, and preserved. Of this liquid 200 grain measures should be exactly decolourized or discharged by half its bulk (100 grain measures) of the solution of chemick at $\frac{1}{2}^{\circ}$ Tw.

To make up the test for use, we mix 2 measures of the arsenic liquor, 4 measures of the indigo liquor, and $7\frac{1}{2}$ measures of water, making $13\frac{1}{2}$ parts of measure.

In testing, a strong graduated phial is taken, about 8 inches high by $1\frac{3}{8}$ in diameter. It is graduated in accordance with actual trial into divisions, each equal to $\frac{1}{10}^{\circ}$ Tw. of chloride of lime. The degrees may be scratched on the glass with a writing diamond, and in default with a rock crystal; $\frac{2}{10}^{\circ}$ Tw. = mark 2 on the phial, $\frac{3}{10}^{\circ}$ = 3, and so on. Of the weakest strength, mark 2, 1,125 grain measures of chloride of lime will be taken to bleach 100 grain measures of the test solution; at 3, 750; 4, 562 $\frac{1}{2}$; 5, 450; 6, 375; and 8, 281 $\frac{1}{4}$. The mark 8 is of course nearest the bottom of the vessel.

The method of working this test is as follows:—

One hundred grain measures of the mixed test solution is put into the graduated glass, and a little of the chemick solution is then added by degrees, shaking the glass on each addition till the colour of the test-liquid disappears. Care must of course be taken not to add more of the chemic than is exactly needed to discharge the colour. The number of divisions on the graduated glass at which the liquid stands shows the strength of the chemic in tenths of a degree Twaddell. Thus suppose the liquid stands at 5, the strength of the chemic is $\frac{5}{10}$ or $\frac{1}{2}$ Twaddell.

After the chemicking it is advisable to wash again before passing into the final or so-called "white sours." This

is sulphuric acid at 2° Tw. The goods are run through this liquid, and are then left to lie in a heap, or in technical language are "piled" or "cuttled." But they must not remain in this state so long as to become dry at the edges of the folds, otherwise tendering is occasioned. The pieces are then washed so as to remove every trace of acid. The slightest remnant if not washed away will rot the tissue.

As regards the acid used in the first souring process, "lime sours and grey sours," it is plain that the hydrometer alone can in this case give no clue to the strength of the acid, since as every piece brings with it into the sours a certain quantity of lime the acid is gradually neutralized and its acidity is decreased, whilst its specific gravity as shown by Twaddell may even be increasing. In order to know its strength a rough acidimetical test is applied. A solution of caustic soda at 25 $\frac{1}{2}$ ° Tw. is made up and kept for use in a stoppered bottle. A noggin (= 5 fluid ozs.) of the sours is taken up and poured into a large glass or white pot, and into it the soda-lye is dropped from a graduated tube or other glass, stirring after each addition till a piece of turmeric test-paper, dipped into the liquid, turns faintly brown. The tube is graduated into divisions each equal to $\frac{1}{2}$ fluid oz. Every such division represents 1° Tw. of muriatic acid. If the soda-lye is kept in a bottle with a glass stopper, care must be taken to grease the stopper from time to time to prevent it from sticking fast.

The kiers generally preferred are Barlow's, though Pendlebury's, which are very similar in principle, are often used on the small scale.

After the last washing the water is to a great extent removed from the pieces by a passage through the squeezing machine. Opening out and drying complete the entire process, which now, where carried to the greatest perfection, takes five and a-half days.

Goods which are to receive a uniform full and deep

dye, *e. g.* Turkey-reds, receive a less severe treatment. Low-pressure kiers are employed with about 8 lbs. of steam. The goods are washed without singeing, boiled in plain water for two hours, and washed. They are next boiled twice in the kier, each time for two hours, with soda-lye. The proportions are per ton of cloth, for the first boil 10 gallons caustic soda at 70° Tw., and for the second 7½ gallons at the same strength. Each of these lye or ley-boils is followed up by a washing. They are then soured for two hours in weak sulphuric acid at 2° Tw., washed and dried.

It will be observed that the use of chloride of lime (chemick) and of a resin soap is here omitted.

For goods which are to be sold in the white state, as also for muslins, curtains, laces, &c., certain modifications are introduced, into which space does not allow us to enter.

Cotton yarns are also bleached in a somewhat different manner, as the artificial impurities present are much lower in amount. The boiling is performed in *open* kiers. The process begins with boiling for six hours in soda-lye at about 32° Tw., of which 20 gallons with 130 gallons of water are used for 1,000 lbs. of yarn. The goods are then boiled in water for about forty-five minutes, washed, passed into chemick at 2° Tw. for two hours, washed for half an hour, then soured for the same length of time with sulphuric acid at 1° Tw., washed again for half an hour, and passed through the washing-machine.

The chemicking, souring, and the washings which succeed them, are generally performed in a specially constructed arrangement. The tank in which the goods are placed has a false bottom through which the liquid passes into a cistern below. From here it is raised by means of a pump, and descends again, through a grating which covers the top of the tank, upon the yarns, thus keeping up a circulation. The tanks and cisterns are in every case made of stone. The gratings, for the bleaching liquor, are of zinc, and for the sours of wood.

A variety of chemicals have been proposed as substitutes for chloride of lime, such as chlorochromic acid, the chlorates, and especially permanganate as recommended by Tessié du Mathey, which has been used with success.

A preparation known as chlorozone, and obtained by passing a mixed current of hypochlorous acid and of common air through a solution of caustic soda, is strongly recommended in some quarters, and is said to have a greater bleaching power than the chlorides (hypochlorites) of soda or potash, without, at the same time, having any tendering action upon the goods. Those who consider that ozone has been all along the true agent in bleaching are reminded that according to the most recent and careful researches (Em. Schoene) its presence in the atmosphere is simply a hypothesis lacking all positive demonstration. The phenomena ascribed to it are very probably due to the peroxide of hydrogen, the value of which in bleaching has been placed beyond a doubt.

Engler proposes an entirely novel process for bleaching spun cotton, especially in cops or bobbins. They are placed in a special chest lined with lead or enamelled tin, about 3 yards long, 2 high, and $1\frac{1}{2}$ wide, containing about 330lbs. of cotton. This chest is connected by a flexible tube with an apparatus in which vapours of chloroform are generated by means of the following mixture:—

Quicklime	1 part.
Chloride of lime	1 „
Alcohol or acetic acid	1 „
Water	4 „

Sulphuric acid is also added.

The vapours are passed into the receiver to the cotton, and allowed to act upon it for two hours at the pressure of two atmospheres, when the bleaching is complete.

A mixture of hydrogen, carbonic acid, and vapour of sulphuric acid (?) is then generated and passed into the chest to remove the smell of the chloroform.

This process can only serve as a substitute for the "chemicking."

Bleaching Linen.

Linen contains a much larger proportion of natural impurities than cotton; the fibre, *i.e.* the cellulose, is coated with a greyish yellow incrustation, consisting of pectic and metapectic acids, along with colouring matters not yet thoroughly examined, fats, &c.

At the same time the fibre is more easily tendered than cotton, so that a tedious repetition of the various processes becomes necessary, and exposure to the air on grass can rarely be avoided. Hence the operation of linen bleaching may extend from a fortnight to six weeks, a circumstance which tends to render the linen manufacture less profitable than that of cotton.

It is remarkable that the process of steeping in water and inducing fermentation by the addition of an infusion of malt or yeast has been reintroduced, it is said, with good results. Linen loses in the bleaching process nearly a third of its weight. It is maintained that flax may be prepared for manufacture without the process of water-steeping or "retting," so that if this is done it is much lighter in colour and may be obtained almost perfectly white by being simply well washed with soap.

A system for linen-bleaching given by Dr. Ure as extensively followed in Scotland and Ireland, consists of thirteen successive processes:—

1. Wash.
2. Boil for ten to twelve hours in lime-water.
3. Sour for three to five hours in dilute muriatic acid at 2° Twaddle.
4. Wash well, to remove all traces of muriatic acid and of the chloride of calcium.

5. Boil for twelve hours with resin soap, *i.e.* resin and soda-ash.
6. Turn the goods in the kier, placing those which were at the bottom uppermost, and repeat the boiling.
7. Wash thoroughly.
8. Give the first chemick for four hours at $\frac{1}{2}^{\circ}$ Tw., and wash.
9. Sour at 2° Tw.
10. Wash.
11. Boil for ten hours with soda-ash.
12. Second chemick.
13. Wash and dry.

This process is chiefly used for goods to be printed.

The following method is employed in the Perth district for shirtings, &c. :—

1. Put up in lots of 35 cwt.
2. Steep in lye for twenty-four hours.
3. Wash and spread out on grass for about two days.
4. Boil in lime-water.
5. Turn the goods in the kier from top to bottom and boil again, using 60 lbs. lime each time, and 600 gallons lime-water.
6. Wash, sour for four hours in sulphuric acid at 2° Tw., and wash again.
7. Boil for ten hours with 110 lbs. soda-ash.
8. Wash and spread out on grass.
9. Boil again with 110 lbs. soda-ash as before, and wash.
10. Spread out on grass for three days.
11. Examine; take out the white pieces, and boil and spread out again such as are not finished.
12. Scald with water containing 80 lbs. soda-ash, and wash.
13. Chemick at $\frac{1}{2}^{\circ}$ Tw.
14. Wash and scald.
15. Wash, chemick again, and wash.

16. Sour for four hours with sulphuric acid at 2° Tw.
17. Wash and dry.

It must be noted that if the chloride of lime is introduced at an earlier stage of the process the brown colouring matter of the flax instead of being removed is fastened, or as it is technically called, "set."

In the patent process of Jennings the alkali and the chloride (of soda in preference to lime) are introduced at once in the hope of preventing the formation of any insoluble brown compound:

1. Soak the goods in water for twelve hours. Boil in lime-water, and in soda-ash, and in soda along with lime, the alkali being 3° to 5° Tw. Sour.
2. Boil again in a similar alkaline lye.
3. Wash.
4. Put in solution of soda at 5° Tw., adding chloride of soda till it rises to 6-7° Tw., and steep for some hours. Pass through squeezing machine.
5. Soak, sour, and wash.
6. Steep in soda and chloride of soda a second time.
7. Wash and boil again with soda. The operations 6 and 7 are repeated till the goods are perfectly white.

The following methods are given in Spon's "Encyclopedia of the Industrial Arts" as the most recent Irish processes for 3,000 lbs. of brown and of cream linen respectively.

1. Lime with 250 lbs. lime.
2. Lime, boil for fourteen hours with 3 to 8 lbs. steam, and wash in the stocks for forty minutes.
3. Sour from two to six hours in muriatic acid at 2½° Tw.; wash in stocks for forty minutes, turn hanks, and wash for thirty minutes more.
4. Give two lye-boils: 1st, 60 lbs. solid caustic soda, 60 lbs. resin, previously dissolved together at a boil, 400 gallons of water. Boil eight to ten hours, run off the liquor, and add, 2nd, 30 lbs.

caustic (solid) soda, dissolved, 400 gallons water. Boil for six to seven hours, and wash forty minutes in the stocks.

5. Spread out on grass for two to seven days, according to the weather.
6. Chemick for four to six hours at $\frac{1}{2}^{\circ}$ Tw., and wash forty minutes in the stocks.
7. Sour for two to three hours in sulphuric acid at 1° Tw., and wash forty minutes in the stocks.
8. "Scald" by boiling for four to five hours with 15 to 25 lbs. caustic soda in 400 gallons water. Wash for forty minutes in the stocks.
9. Spread out on grass for two to four days.
10. Chemick for three to five hours at $\frac{1}{4}^{\circ}$ Tw., and wash in the stocks for forty minutes. At this juncture the pieces are sorted over, those which are ready being taken away for the final souring and washing, whilst the others are
11. Rubbed with soft soap.
12. Spread out on grass for two to four days.
13. Chemick for two to four hours with chloride of lime at $\frac{1}{6}^{\circ}$ Tw., and wash in stocks for forty minutes.
14. Sour in sulphuric acid at 1° Tw. for two to three hours, and wash in stocks for forty minutes.

For the same weight of cream linen :—

1. Lime with 160 lbs. lime.
2. Lime-boil for ten to twelve hours with 3 to 8 lbs. steam, and wash in the stocks for forty minutes.
3. Sour for two to four hours in muriatic acid at $2\frac{1}{2}^{\circ}$ Tw., wash in stocks for forty minutes; turn hanks, and wash thirty minutes more.
4. Give a first lye-boil with 200 lbs. soda-ash and 60 lbs. resin, previously boiled together in water till dissolved. Boil for six to seven hours, and wash in the stocks for forty minutes.
5. Spread out on grass for two to seven days.

6. Chemick for three to four hours with chloride of lime solution at $\frac{1}{4}^{\circ}$ Tw., and wash for forty minutes in stocks.
7. Sour for two to three hours in sulphuric acid at 1° Tw., and wash in stocks for forty minutes.
8. Give second lye-boil, or "scald," boiling for four hours with 400 lbs. soda-ash and 400 gallons water; wash for forty minutes in the stocks.
9. Rub with a good solution of soft soap in the rubbing machine.
10. Spread out to grass for two to four days.
11. Chemick for three to four hours with chloride of lime solution at $\frac{1}{8}^{\circ}$ Tw., and wash for forty minutes in the stocks.
12. Sour for two to three hours in sulphuric acid at 1° Tw., and wash forty minutes in the stocks.

The machinery used in linen bleaching differs in many respects from that employed for cottons. In case of yarns or threads the kiers are generally provided with a false bottom, connected by ropes to a crane, so that when the boiling is over and the liquor has been run off, the whole of the yarn can be lifted out at once.

For bleaching small quantities of linen yarn it is generally boiled for five or six hours in a bath of caustic soda, washed, and passed into a solution of bleaching lime at $\frac{1}{2}^{\circ}$ Tw., when it takes a yellow shade. It is then well washed, spread out on the grass for several days exposed to the sun, sprinkled frequently with water, and turned until it becomes perfectly white.

It will be seen that as long as exposure to the air and sun is an essential part of the process of linen-bleaching, the trade will be necessarily confined to districts where the air is free from soot and smoke, and where room is plentiful.

The peculiarities of linen bleaching as compared with cotton bleaching depend mainly on the circumstance that

the fibre of linen is more easily affected and destroyed by chemical agents than that of cotton.

Bleaching Jute.

Jute is still less tolerant of chemical agents than linen, especially of acids. For bleaching 50 lbs. the following process is recommended :—Make up a solution of 5 lbs. soap at 140° F., and pass the jute five times through it. Rinse in clean water.

For the chemick bath mix $2\frac{1}{2}$ lbs. of chloride of lime with an equivalent quantity of sulphate of magnesia (Epsoms), both dissolved in water. Stir up, let settle, dilute to $\frac{1}{2}$ ° Tw., steep the jute for three hours in the cold, taking care to keep the goods below the surface of the liquid. Take out and wash well.

The operation of exposing vegetable fibre of any kind to sun, air, and moisture is known in some parts as “crofting,” and in others as “grassing.” The process of boiling with alkali and soap is known as “bowking,” and the liquid in the kiers is spoken of as the “bowking liquor.”

Bleaching Animal Fibres.

For bleaching wool, hair, and silk the chlorides of lime, soda, magnesia, &c., are utterly useless, since they not merely fail to remove the natural colouring matters, but leave the fibre darker than it was before, besides injuring its properties in other respects. In place of the chlorides is used sulphurous acid, either in the dry state, as generated by burning sulphur, or in the moist way by means of the bisulphites of soda, magnesia, or lime, as has been already mentioned, p. 4.

The preparatory removal of the “grease” of the wool

(suint, a combination of potash with certain fatty acids), as well as the extraneous dirt contracted in transport and in spinning and weaving, is effected by washing with soap, alkaline carbonates, and stale urine. The latter liquid, known in Lancashire as "lant," and in Yorkshire as "wash" or "weeting," owes its action to the carbonate of ammonia formed by the decomposition of the urea.

Many dyers, however, maintain that the ordinary ammonia as obtained from gas-liquor, whether used in the caustic or the carbonated state, does not leave the fibre in as "kindly" a condition. Consequently, in the woollen manufacturing districts, urine is still diligently collected, and is in such demand that it is worth adulterating with brine.

Alkaline liquors of any kind are never applied to wool in a very concentrated state, and, of course, never under pressure, when the wool would be rapidly attacked, and dissolved to a jelly.

If a particularly beautiful finish and lustre are required for worsted goods to be sold undyed, so-called "double stove-whites," after sulphuring in the stove or in the bisulphite bath, are steeped in a decoction of Panama bark, *Quillaja saponaria*.

Woollen dyers are often induced to buy preparations for scouring soap at prices much above their real value. Such compounds have been sold as urine substitutes, washing sugars, extracts of fullers' earth, saponaceous, French borax powder, &c.

Bleaching Silk.

We will begin with a mention of the most recent improvement which is applicable not merely to silks, but to hair, feathers, fine leathers intended for dyeing, furs, &c.

The agent, to which we have already referred in passing,

is the peroxide of hydrogen, for the use of which the following instructions are given:—

The articles to be bleached must be freed from all mechanically adhering dirt, grease, &c. This is effected, according to the nature of the article, and of the impurities to be removed, by means of soap, ammonia, sulphuret of carbon, ether, or alcohol. These cleansing agents must then be entirely removed, either by washing or by evaporation. A bleach-bath is then made up with the peroxide of hydrogen, either alone, or along with small traces of ammonia or of soda-lye. The silks are simply laid in this liquid, and left to steep as may be required. The process is accelerated by heat not exceeding 77° F., and by the light of the sun. The bleaching process may last from two to fourteen days. When it is completed, the silks are rinsed in condensed steam-water, and carefully dried.

Some silk-bleachers in Lyons employ an *aqua-regia*, prepared by mixing five measures of muriatic acid with one of nitric acid. The mixture is left to stand for at least four or five days at a gentle heat, say about 77° F. For use, it is let down with water so as to mark about 3° to 4° Tw. This dilution is carried on in square tanks, hollowed out of grit-stone. The temperature of the liquid for use does not exceed 70° F. The skeins are placed upon rods, plunged into the bath, and worked constantly, by turning them round, and drawing them from one end of the trough to the other. The process is complete in from ten to fifteen minutes, or even less. The silks are then taken out, and steeped in succession in two baths of water, in order to remove at once every trace of acid.

It is slower, but safer, to work at a lower temperature, *i.e.*, 50° F.

Guinon, Marnay, and Pouset, instead of *aqua-regia*, employ a solution of chamber-crystals.

The final whitening of silks, however, is generally effected by means of the fumes of burning sulphur, or by a passage

through a solution of bisulphite of soda, as directed for wool.

In case of raw silk, before any of these decolourizing processes can be applied, it must be freed from certain matters which, though natural to the fibre, would interfere with its being properly bleached and dyed. The true fibre of the silk, a peculiar nitrogenous substance named fibrine, does not constitute more than 50 to 54 per cent. of the raw material, the residue being made up of albuminous and gelatinous matter, wax, fatty, and resinous matters, and small quantities of colour.

Much of this extraneous matter is removed by scouring with soap, a delicate operation which should be performed so as not to injure the lustre, the suppleness, or the elasticity of the fibre. The loss of weight in this process is from 18 to 22 per cent. in Japanese and Chinese silks, but in those of Italian and French growth it may even exceed 25 per cent. The desire to compensate themselves for this loss has gradually led silk manufacturers to the fraud of "weighting." The soaps used for silk scouring must be of the finest quality, thoroughly neutral, and free from unpleasant odour. For silks to be dyed oleic acid soaps are used, but such as are to remain white are scoured with an olive-oil soap. The quantity of soap required is very considerable, and for whites may reach 60 per cent. of the weight of the raw silk. If the silk is to be dyed a black or other dark colour a single boiling is sufficient. For whites and those which are to be dyed light, brilliant colours, there are two successive operations, ungumming (*dégommage*) and boiling. For the first process the silk is steeped in very dilute muriatic acid, and is then very well washed, so as to remove all traces of acidity. It is then entered in a boiling bath of 33 lbs. of soap per 100 lbs. silk, and turned for 30 to 45 minutes. The silk is then taken out and drained. If the colour in view is not very pure, the silk may have its second treatment known as "boiling" (*cuite*) in the same bath. If it is to be a very pure white,

or if it has given off much colouring matter, it is put in bags of a coarse hemp tissue, and boiled for two or three hours in a fresh water, with 17 lbs. soap per 100 lbs. silk.

After this process the silk is taken out of the bags, rinsed in a lukewarm, weak solution of borax, or in default, of carbonate of soda crystals, and then washed in water.

Borax has been successfully used instead of soap.

In China silks are scoured with carbonate of potash or of soda, but this method has been nearly abandoned in Europe on account of the amount of care and attention it requires. From 10 to 12 lbs. of carbonate of soda are required for 100 lbs. of raw silk. The scouring-bath is not allowed to get hotter than 185° Fahr., and the process may last from 60 to 90 minutes. The action is considered to have gone far enough when the threads give a kind of crackling sound if rubbed with the finger-nail. Two or three washings with lukewarm water complete the process. The loss is rarely below 18 per cent., and may rise to 28.

Caustic soda is used in very weak solutions for coarse kinds of silk. From 3 to 4 lbs. solid caustic is sufficient for 100 lbs. silk. It is dissolved in about 300 gallons of water at 140°, and the yarns are worked for 30 minutes and are then washed. The loss does not exceed 12 per cent.

If silks have been woven in the raw state, and require to be scoured and bleached in the piece, they are subject to a singeing process with gas, as has been mentioned under cotton.

Ungumming and boiling then follow as in case of yarns. The pieces are winced for an hour at 212° Fahr. in the soap-liquor from a former operation. They are then wound out of the lye, let drain on the wince, and run again for two hours in a fresh lye of 30 to 40 per cent. of good olive-oil soap at a gentle boil. It is then again wound out, let drain, and rinsed by running for about a quarter of an hour in a weak solution of carbonate of soda crystals or of

borax. After a final rinsing in cold water it is ready for dyeing—if for blacks or dark colours—or for bleaching if it is to remain white or be dyed a light colour.

WATER FOR DYEING AND PRINTING.

The selection of water for dye and print works requires considerable care. It should be as nearly as possible pure, and consequently soft. The supply may be derived from rivers or lakes into which no manufacturing refuse can find its way, or from the drainage of moorlands, or springs in grit-stone, slate, or granite mountains. The water of artesian wells, though often suitable for domestic uses, is rarely, if ever, fit for dyeing, as it is generally hard, from the presence of compounds of lime, magnesia, and iron. The action of such hard waters is most unsatisfactory; they waste soap, partially decompose mordants, and extract, or as it is technically called, *bleed* the dye-wares very imperfectly; much of the colouring matter, instead of dissolving out into the water, remaining in the wool, &c. in combination with the lime, magnesia, &c., of the water. Hence there is in a year's working a very decided balance against a dye-house using hard water as compared with a similar one supplied with soft water. The work is not merely done at a greater cost, but it is worse done. The very smallest traces of iron interfere with all light and bright shades, and even lime and magnesia have a "saddenening" or darkening effect. For alizarine (madder) work, indeed, lime to a certain extent seems to play a necessary part, but it is better to have a pure water to begin with and to add chalk or acetate of lime in cases where its presence is required. Of all the salts of lime, sulphate of lime (gypsum) is the most injurious. Salts of magnesia,

especially the bicarbonate, are, of the two, worse than those of lime, and have been found by the most careful observers harmful in case of madder work. The only circumstances under which hard waters generally have an advantage is, in dyeing blacks and other sad colours, as they here produce the desired effect at a less outlay of wares. But, as in the case of madder-work, this advantage may be secured by adding a little chalk to the dye-pans for dark colours.

Alkalies, such as soda, are not often met with in natural waters, but where they do occur they are scarcely less mischievous than lime and magnesia. They do not, indeed, harden nor occasion any waste of soap, but they waste acid, mar and seriously modify the shades of many dye-wares. Cochineal scarlets cannot be dyed with an alkaline water without previously neutralizing it with an acid, of course a matter of some expense.

Brackish waters, *i.e.*, such as contain a proportion of common salt, are not necessarily injurious, except the impurity be very large.

Soluble sulphurets, sulphuretted hydrogen, &c., are fatal. All colours containing lead, tin, copper, or iron, &c., in the shape of mordants are affected by them, and in case of lead the change may extend to complete blackening. Hence sewage and excrementitious or putrescent matter generally, the drainage of cesspools, graveyards, slaughter-houses, &c., have to be avoided. Water from peaty soils, except so deeply yellow as to give a perceptible yellowness, is very little to be feared, as it contains tannin, which aids in the fixation of many colours and can scarcely be said to injure any. But great care must be taken to make sure that the yellowish cast of any sample of water is due to crenic, apocrenic, &c., acids, and other peat products, and not to any compound of iron.

Sand, clay, insoluble oxide of iron, and fragments of organic matter, may be easily removed by settling and filtration, and turbidity which can thus be overcome need not

be objected to. Drainage from woodland pools, coloured greenish with the juices of decaying plants, is not safe.

Rivers passing through populous districts, and especially in manufacturing parts, may contain many formidable impurities besides those present in natural waters, and in addition to sewage pollution. Among the most serious are free acids, oily, greasy, or resinous bodies, so-called lime and magnesian soaps such as are produced when soap is decomposed by hard waters, diluted solutions of various dye-wares and mordants, compounds of chromium, &c. These impurities are the more to be feared as, especially in small streams, they may vary in the course of a few minutes, and cannot therefore be overcome by any one system of treatment. Drainage from coal and iron mines, from ochre-beds, and from deposits of iron or aluminous shales should be carefully avoided.

It is hence necessary to be very cautious, not merely in selecting sources of water for new bleach, dye, or print works, but in old establishments, at least if supplied from a river. It is necessary to be watchful, lest mining or engineering operations, or the establishment of some new manufacture higher up stream, may affect the quality of the water, and do unexpected damage.

The character of a water may be to a very great extent judged of by mere inspection, without chemical tests. If there is a rainbow-coloured scum upon the surface in still places, or if ochrey matter is deposited upon stones, &c., the water is to be condemned as containing iron. A scum may, however, be occasioned by oily or tarry matter, which is quite as objectionable.

The tests for the principal impurities are as follows. Let a quantity of the water settle, and filter if needful. Observe if it has any colour, or if it has any action upon blue or red litmus paper. If it turn the former to a red it is of course acid, and if it change the latter to a blue it is alkaline, and should in either case be rejected if any better quality is to be had.

Put a pint of the water in a bottle, cork it up, and let it stand for a few hours in a warm place. On shaking and uncorking, sulphuretted hydrogen, if present, may be detected by the smell.

To confirm this test observe whether it blackens moist carbonate of lead; or as a most delicate test for sulphurets, add to the water a few drops of a solution of the nitro-prusside of potassium, when a fine purple tinge will appear if sulphurets of sodium, &c., are present.

For the detection of iron boil down a quart of the water to about four ozs. in a white porcelain dish, and note if any ochre is deposited. Divide the concentrated water into two parts. Add to the one an extract of gall-nuts or solution of tannin, set it aside, and note if a blackish and brown colour appears on standing for a short time. To the other portion add a mixed solution of yellow and red prussiates of potash, and observe if a blue precipitate or colouration is formed. Either the darkening with galls or the blue colouration with the prussiates is a sign that iron is present.

If anything resembling ochre has been deposited during the boiling down the water, add to it a few drops of muriatic acid, and apply heat. If the deposit or stain dissolves, heat gently to expel all superfluous acid, dilute with a little water, and apply the mixed solution of the red and yellow prussiates as above. If a blue colour appears the deposit consists, in part at least, of iron.

To detect sulphuric acid and soluble sulphates, add to the water a few drops of pure muriatic acid and a solution of chloride of barium. The presence of sulphuric acid is shown by a white turbidity, or if the quantity be sufficient a precipitate. There are few natural waters which do not show a slight cloudiness if submitted to this test.

For the detection of muriatic acid or a soluble chloride, such as common salt, there are added to a portion of the sample in question a few drops of pure nitric acid, and a little of a solution of nitrate of silver. If muriatic acid or

a soluble chloride is present, there will appear a white precipitate which quickly turns a blackish blue on exposure to sunlight.

For the detection of lime, concentrate the water as before to a small part of its bulk, and add a few drops of solution of oxalate of ammonia. A white precipitate shows the presence of lime, which to some extent is found in every natural water.

The detection of magnesia, along with lime and in the possible presence of alumina, is somewhat more circumstantial. Perhaps the most convenient process is to evaporate the water down to dryness in a platinum dish along with a little muriatic acid. The dry residue is moistened with a few drops more muriatic acid, distilled water is added, and the solution is filtered. To the liquid which runs through the filter there is added ammonia, in excess and the mixture is boiled and filtered again. To the filtered liquid thus obtained there is added oxalate of ammonia, to throw down the lime. This is filtered off, and the clear liquid is concentrated down to a very small bulk with a drop or two of muriatic acid, if necessary, and the residue is mixed with a little ammonia and set aside. If a fresh precipitate falls, this also is filtered off as lime, and to the filtrate is added phosphate of soda and ammonia. If a precipitate is formed, it is magnesia in the state of the ammonia—phosphate of magnesia.

The detection of chromium, of arsenic, and of antimony, —metals which may possibly occur in rivers which receive manufacturing refuse—had better be left to an experienced analyst.

The detection of soluble organic matter is effected by adding to the water a few drops of the permanganate of potash. If the water contains organic matter, the light pink colour of the permanganate will rapidly disappear, and the hydrated peroxide of manganese will be deposited as a brown sediment.

The following simple process, devised by Slater, has

been found very convenient for judging the suitability of water for dyeing purposes. A standard colour solution is made by digesting distilled water for twenty-four hours upon a large excess of ground logwood in a stoppered bottle. The clear liquid is carefully poured off at the end of this time, and preserved for use in a stoppered bottle. If it is required to examine a number of samples of water, procure a set of clear white phials, holding about five ozs. each. Put into one of them four ozs. distilled water and add 100 grain measures of the logwood liquor. Put four ozs. of each sample in one of the other bottles, add 100 grain measures of the logwood liquor to each, and compare the colours. The phial with distilled water will be of a clear reddish amber colour. The others will depart more or less from this standard, according to the nature and the quantity of their impurities. If a soluble chloride (muriate) is present the colour produced will be yellower than in case of distilled water.

Sulphate of lime and alkaline sulphates, if present, give a yellowish olive tint. Alkalies, whether caustic or carbonates, produce a brownish red; alum, sulphate of alumina, &c., a kind of plum-colour; free acids yield a cherry-red; whilst the salts of iron and the chromates give a brownish black. A few experiments made with pure water, to which these various substances have been purposely added, will soon enable the student to judge with practical correctness, not merely as to the presence, but even the proportion of the substances mentioned above.

The hardness of water—that is, its power of destroying soap—is estimated by the test first proposed by Clark, and since, with certain improvements, brought into general use. Like the logwood test, it is a reproduction on the small scale of what is done on the large scale in actual work. The process is called the soap-test. The first step is to make up a standard solution of soap by dissolving a convenient quantity of soap—generally the soft soap (potash-soap) of the London Pharmacopœia—in methy-

lated spirit, previously mixed with an equal quantity of water. The mixture is let stand, without heat, in a corked bottle till all the soap is dissolved and the solution has become clear. If muddy it is filtered, and in any case the liquid is preserved in stoppered bottles.

The next step is to find the value of this solution. For this purpose a standard hard water is made up by grinding $27\frac{1}{2}$ grains of pure sulphate of lime (selenite) to a fine powder, adding it to an exact gallon of distilled water, and letting it dissolve. As $27\frac{1}{2}$ grains of sulphate of lime are equivalent to 16 grains of carbonate of lime, Clark called this solution standard water of 16 degrees of hardness; each grain of carbonate of lime, or its equivalent of any other hardening substance, *i.e.*, salts of magnesia, alumina, or iron, being assumed as a degree of hardness.

This standard solution is now tested against the soap-liquid. For this purpose 1,000 grain measures of the sulphate of lime solution are poured into a stoppered bottle which may conveniently hold 6 ozs. Forty grain measures of a solution of carbonate of soda (crystals) saturated in the cold are added. A graduated burette is filled with the standard soap solution, and it is dropped into the bottle. After a small quantity has thus been added, the bottle is closed and shaken up. If the froth produced on shaking rapidly vanishes, the lime is not yet saturated. The bottle is therefore opened and more of the soap-liquor added. The stoppering and shaking are repeated until at last a point is reached when a plentiful creamy froth is formed and remains without breaking up for about five minutes, the test is completed, and the number of degrees on the burette which have been consumed can be noted. Suppose 48 degrees of the soap liquor have been used, then three such degrees represent one degree of hardness.

The respective values of the soap liquor and the sulphate of lime liquor having thus been fixed, waters are tested in the same manner.

One thousand grain measures of the water in question

are put in the bottle, 40 grain measures of the carbonate of soda solution are added just as before, and the soap solution dropped in till a permanent lather is obtained.

If the water is found to be harder than the standard solution, it is well to dilute the sample before testing with a known measure of distilled water, and the result obtained is multiplied accordingly. Thus if one measure of the sample has been let down with two measures of distilled water the figure resulting is multiplied by three. As a general rule, if the hardness of a water exceeds 4 or 5 degrees, it should be rejected, or only made use of after it has undergone some softening process. A very simple and ingenious method for this purpose has been devised by Clark, and is in use at various places on the large scale. It will be described below.

It will be seen that this process shows very fairly the value of a water for all purposes in which it has to be used along with soap. The quantity of soap which has to be added to any water before it can be made to lather freely, contributes nothing towards cleansing the goods for which it is used, and is simply wasted. It is something more than wasted. The fatty acids of the soap combine with the lime of the water to form so-called lime-soap, a glutinous, smeary compound which attaches itself to the wool, or cotton itself, encloses any dirt present, and if not removed leaves the fibre in a state unpleasant to the feel, and objected to by purchasers. Of the difficulty of removing this film anyone may convince himself by the simple experiment of washing his hands with soap and hard water.

However, Clark's process is not as decisive on the value of a water for dyeing or printing as it is for scouring and bleaching. Hard waters are in no case to be preferred, but two waters may mark equal degrees of hardness, and yet the one may be very much worse than the other, according to the nature of the hardening ingredient.

There are, in fact, two kinds of hardness, technically

spoken of as *temporary* and *permanent*. If we take, e.g., a sample of water direct from the spring and determine its hardness as above, we get a certain figure. If we then take a fresh portion of the same water, boil it well, and test it over again, we get in almost every case another and a smaller figure, the difference being sometimes very considerable. This second value is spoken of as the *permanent* hardness, whilst the figure attained with the cold water in its original state is the *total* hardness, and the difference between the two is spoken of as *temporary* hardness. When we thus make a double determination of the hardness of a water and find a difference, we have got at the important fact that a portion—more or less, as the case may be—of the hardness of such water is due to the carbonate of lime or of magnesia or of both, rendered temporarily insoluble by the presence of carbonic acid. On boiling the water this excess of carbonic acid is expelled, and the carbonates of lime and magnesia being almost insoluble in water containing no carbonic acid, are precipitated, and cease to have any effect in increasing the hardness of the water.

On the other hand, if we find that the hardness of a water before and after boiling is substantially the same, we may safely infer that such hardness is due to sulphates of lime and magnesia, chlorides of calcium (muriate of lime), and magnesium, or possibly to salts of alumina and iron. These last-mentioned salts, the sulphates and chlorides, are also the cause of the permanent hardness of waters which are partially softened on boiling.

It appears, then, that hardness due to sulphates and chlorides, &c., is incurable, while hardness due to carbonates held in solution by means of free carbonic acid may be overcome. Any process which expels or seizes hold of such free carbonic acid will answer the purpose. Boiling is on the large scale rarely practicable. Mere exposure to the air in large tanks or reservoirs softens such waters to a considerable extent.

But the cheapest and most efficient process is that of Clark, above referred to. He adds to such waters milk of lime—in other words, a solution of caustic lime—proportionate to the hardness of the water. The free carbonic acid immediately seizes hold of the lime introduced, forming the insoluble carbonate of lime, and is of course no longer able to keep the carbonate of lime previously present in a state of solution. The consequence is that both lots of carbonate of lime, that originally existing and that just formed, are precipitated together, and the water, if its hardness was caused simply by dissolved carbonates, is rendered beautifully soft and fit for dyeing purposes. This same treatment, it must be further remembered, removes at the same time compounds of iron, if present, and many kinds of organic impurities.

MORDANTS.

Comparatively few colouring matters are capable of attaching themselves to organic fibres and surfaces, and even those which do so are rendered brighter and more permanent by the intervention of a class of bodies called mordants (German, *Beizen*). The vegetable fibres, especially, such as cotton, have in themselves a very slight affinity for the great majority of colours, and in dyeing and printing such fibres or tissues the use of mordants can rarely be dispensed with. A thorough knowledge of these bodies is therefore one of the necessary branches of training in the tinctorial arts. The subject is somewhat complicated, because a distressing confusion reigns in the names of bodies used in the tinctorial trades in different parts of the country. Some of these terms, as the author has remarked elsewhere, have taken their rise in the dye-

house, others are corruptions of foreign words, and others again are specimens of every stage through which chemical theory has passed. Further, the resources of the tinctorial arts are so great that different dyers and colour-mixers obtain one and the same results by very different procedures, and what one practical man pronounces necessary, another rejects as worthless, neither of them being able to give an intelligent reason for his preference.

The theory of mordants, so far as it can be given, is briefly this: the mordant, or some portion or constituent thereof, becomes attached to the animal or vegetable fibre, and modifies it to such an extent that the colouring matter is now able to attach itself, not as a mere fugitive stain, but with considerable permanence, and in such proportion as to give it a full body of colour. As regards the greater number of the true mordants, such as the compounds of iron, alumina, tin, &c., the process which goes on is very like the formation of so-called "lake" colours. If we take a decoction of cochineal, or of any of the dye-woods, perfectly clear, and free from all suspended matter, and add to it a little of a solution of alumina or of tin, as neutral as possible, we see the liquid shortly become turbid, and a sediment falls gradually to the bottom, consisting of the colouring matter of the wood, &c., and of the hydrated oxide of alumina (or tin), or, what is more probable, a sub-salt or basic salt of either of these metals. If an animal or vegetable fibre has been prepared with a solution of alumina or tin, and is then steeped in the colour solution, the deposition or precipitation of colouring matter takes place on its surface, or rather in its pores. Or if the colouring matter and the mordant are mixed together, and the fibre to be dyed is then plunged into the mixture, as is generally done in wool and worsted dyeing, the lake, in virtue of an attraction which it possesses, is deposited upon it, rather than upon the bottom of the vessel. It must be remarked that the above explanation is not universally applicable. There are cases in which the process

must be totally different. Thus, if cotton is treated with a mixture of strong sulphuric and nitric acids, so as to convert it into gun-cotton, its power of taking up colouring matters is considerably increased. But no hydrated oxide or basic salt can have been deposited on the fibre; the cotton has rather undergone a change in its nature, which causes it to behave with colouring matters more as does wool or silk. The action of argol (tartar, bitartrate of potash) and that of finely divided silica and sulphur, all of which are in certain cases employed as mordants, cannot be explained on the above principle. No base capable of combining with colour-acids is deposited on the goods to be dyed. For the organic mordants, such as tannin, the emulsive oils, albumen, and the like, it is also of no value. It is suited merely or mainly to such colouring-matters as have the properties of feeble acids, as is the case with the majority of the old colouring matters. That the colour, *e.g.*, of cochineal, carminic acid, should form an insoluble compound with oxide of alumina and of tin, is not to be wondered at.

The practical conclusion to be drawn from these considerations is that the bulk of the new coal-tar colours, not being acids, cannot be expected to be fixed by the class of mordants above mentioned. This is what has been found in practice. Had it been known, *e.g.*, that magenta was not an acid, like carmine, like brasileine, hematine, &c., but a salt—the acetate of rosaniline—and that it could only be fixed upon vegetable fibre as such, the many vain attempts made to fasten it upon cotton with red liquor, alum, &c., might have been saved. Alizarine and anthrapurpurine, however, are true colour-acids, and are accordingly fixed by means of alumina, iron, and tin mordants.

The properties required to constitute a good mordant are not easy to meet with in combination. It must have no destructive action upon the fibre. If it "tenders" the goods, whether as being too strongly acid or alkaline, it

has to be at once laid aside. As an instance may be mentioned the mixtures required for converting cotton into gun-cotton.

A mordant must not "flatten," *i.e.*, dull or deaden, the lustre of the fibre, but, if anything, "raise" or brighten it.

It is to be desired also that the mordant of itself should not alter the colour of the fibre. If this is the case, if, like iron or manganese, it darkens the goods, its use is limited to the darker or sadder class of colours, such as blacks, browns, olives, deep violets, bottle-greens, &c.

A mordant must combine readily both with the fibre and the colour. But this power or tendency must not be too strong. If a colour, whether in virtue of its own nature, or by the aid of a mordant, combines too readily and quickly with the cloth, yarn, &c., the shade produced will be uneven; any portion of the goods which happens to get in a more favourable position will receive more than its fair share, and the other parts less, so that the result will be irregular. Further, if the combination between mordant, fibre, and colour takes place too rapidly, the shade dyed, even if "level," *i.e.*, free from clouds, streaks, or spots, will generally be loose, so as to be capable of rubbing off, and will be either harsh or dull. If the mordant combines more eagerly with the colour than with the fibre, we have a lake, deposited not upon the fibre, but at the bottom of the dye-pan, and the shade is meagre and hungry, in spite of a great consumption of materials. If combination is apt to be too rapid, it is frequently needful to add some material to render it slower, and thus insure regular work.

Mordants, with some few exceptions, must be soluble, so that they may be in a liquid state when brought in contact with the goods and the colour.

But they must be capable of passing into an insoluble condition as soon as their action has taken place. Otherwise, the colour produced would be readily removed by simple washing in water. This conversion into an in-

soluble state is effected in several ways. Sometimes an acid in which the base of the mordant is dissolved is suffered to escape. Thus, if cottons are mordanted with red liquor (acetate of alumina), and exposed to certain conditions of heat and moisture (*see AGEING*), the acetic acid escapes, and the alumina remains in an insoluble state upon the fibre.

Sometimes the mordant is decomposed by mere contact with the fibre, the acid remaining in solution, while the base or a subsalt becomes attached to the cotton, wool, &c. This is a very common result when cloth or yarn is worked in a dilute solution of tin crystals, or nitrate of iron, &c. It is here necessary that the acid must not be so concentrated, or so great in quantity as to dissolve the base off the fibre.

Another case is when a mordant and a colour, each of them soluble if taken singly, become insoluble in combination. Lastly, a mordant may be rendered insoluble upon the fibre by subsequent treatment with some suitable chemical agent. Thus, if cotton yarn has been worked in the aluminate of soda, and is then passed into a solution of sal-ammoniac (muriate of ammonia or chloride of ammonium), the alumina is left upon the fibre in an insoluble state. Similarly, if cottons or delaines are prepared for printing in the steam style by treatment in stannate of soda, and are then passed into weak sulphuric acid, the soda combines with the sulphuric acid, and is removed, whilst stannic acid, *i.e.*, peroxide of tin, remains upon the fibre.

Hence it will be seen that any substance which is to act as a mordant must not be very stable in its nature, but must admit of ready decomposition. The acid and the base must be held together by a very feeble affinity, and must be nicely balanced. If there is too much acid, the mordant may have little or no action, except in destroying the cloth. Such mordants are said to be too "raw." If the acid has been made to take up too much base, the mordant is said

to be too "dead," or to be "over-killed." It works unevenly, and the colours will be loose and dull.

The best-made mordants, if kept too long, or if mixed with a large quantity of water, especially hot, undergo spontaneous decomposition, of a very similar nature to that which happens when they are brought in contact with organic fibres. As a rule, all mordants should be preserved at a uniform temperature, and be protected from the action of light.

Mordants for use in wool-dyeing and printing may be more decidedly acid than those employed in cotton-dyeing. The vegetable fibres, indeed, may be successfully mordanted with alkaline preparations, the uses of which for wool and silk are very limited.

We will now enter upon a description of the various mordants in practical use.

1. *Alum Mordants.*

Of these compounds the best known and oldest is common alum, which exists under two distinct forms, potash-alum and ammonia-alum. The former of these is a double sulphate of alumina and potash, containing 10 per cent. of alumina, 33 per cent. of sulphuric acid, and 45 per cent. of water. Three-fourths of the water is driven off at the heat of 140° F. One part of alum, at 54° F., dissolves in thirteen times its weight of water, in twice its weight at 122° F., and at 189° F. in less than one-tenth of its own weight.

Ammonia alum is a little stronger than potash alum, containing $11\frac{1}{2}$ per cent. of alumina, 35 per cent. of sulphuric acid, and 49 per cent. of water. It has also the advantage of being rather more easily soluble in water. Ammonia alum may be distinguished from potash alum by the smell of ammonia which it gives off if heated with a little caustic soda-lye. Which of these two kinds of alum is most com-

mon in the market depends on the respective prices of sulphate of potash and sulphate of ammonia. Whichever kind is used it should be absolutely free from iron, exceedingly small proportions of which may cause serious injury. To detect iron a concentrated solution of the example is mixed with a few drops of a solution of tannin, or with a small quantity of a mixed solution of the red and yellow prussiates of potash (ferricyanide and ferrocyanide of potassium), as was directed for the detection of iron in water. If iron is present, the addition of tannin will produce a black colouration, and that of the prussiates an immediate blue precipitate or colouration. On standing for an hour or more, a blue tinge will be produced even with pure alum. Another method is to add to the saturated solution of the alum, a couple of drops of pure nitric acid, boil to convert the iron into the state of a peroxide salt, and expel the residue of nitric acid from the liquid and add a drop or two of a solution of sulphocyanide of potassium. If a red colour is produced, iron is present, and the sample should be rejected.

Some examples of alum have a reddish or rusty colour in the lump, from the presence of insoluble peroxide of iron. Such samples are perfectly safe if none of the iron is in a soluble state, which should in such cases be ascertained by testing a portion of the filtered solution.

Alum does not very readily part with its alumina, except at a boil. Hence it is much more used for wool than for cotton dyeing. It is made more available for cotton dyeing, &c., by conversion into what is called *basic alum*. To a solution of either potash or ammonia alum there is carefully added a solution of carbonate of soda so long as the precipitate formed is re-dissolved on stirring. In this manner a portion of the sulphuric acid is neutralized, and the alumina, held less firmly in solution, is much more readily deposited on the fibre. Such solutions of basic alum are generally prepared when wanted.

Alum is generally met with in large crystalline masses ;

that sold in the state of powder is not to be recommended, since it may be mixed with common salt, salt cake, &c., which not only reduce its strength, but tend to introduce iron.

Sulphate of alumina (patent alum, cake alum, concentrated alum, and sometimes even known as *consecrated* alum) consists merely of sulphuric acid and alumina without any sulphate of potash or of ammonia. It contains 15 per cent. of alumina and 35 per cent. of sulphuric acid, and dissolves in twice its weight of water. Being thus both stronger and more soluble than common alum, it is in so far preferable. But it has the disadvantage of not being like common alum, a definite crystalline compound. Some samples of it contain more sulphuric acid than others, a point in which common alum can never vary. Hence dyers have till lately looked upon it with no small suspicion. But as it is now manufactured of greater purity and regular composition, it is making its way in the trade. In any case it is of little immediate use in cotton-dyeing and printing, though it is serviceable in forming other mordants by double decomposition.

The most important of the aluminous mordants for the cotton-dyer and tissue-printer is the acetate of alumina, known also as pyrolignite of alumina, red mordant, and especially as red liquor. This compound is always prepared, sold, and used as a liquid, of a yellowish colour, a sweetish astringent taste, a tarry smell, and a specific gravity which varies greatly, ranging commonly from 8° to 24° of Twaddell's scale.

This mordant may be prepared by dissolving hydrate of alumina in acetic acid of a high degree of concentration. More generally red liquor is made by double decomposition, and as it does not improve by keeping, it is very frequently prepared by consumers.

A solution is made of alum, or of sulphate of alumina—in either case free from iron—and it is decomposed by the addition of a solution either of acetate of lime or acetate

of lead (sugar of lead). The proportions employed vary indefinitely according to the particular purpose in view, and the best results are not obtained by adding the ingredients in strict equivalent proportions. It seems advantageous that a little of the alum or sulphate of alumina employed should remain undecomposed. An excess of the acetate of lime or lead is rarely recommended. Not unfrequently a certain proportion of crystals of soda or of chalk are added, so as to produce in part a basic compound. Other ingredients are sometimes added, which can have little effect beyond raising the specific gravity of the liquid, such as common salt.

Many receipts for the preparation of red liquors for different purposes will be found among the directions for dyeing and printing. The following are given by D. Koechlin:—

	No. 1.	No. 2.	No. 3.	No. 4.
Water (gallons.)	45	45	45	45
Alum (lbs.)	100	100	200	190
Sugar of lead (lbs.)	100	129	200	190
Soda crystals (lbs.)	10	10	10	19

The way of mixing is as follows: the alum is broken up and dissolved in the water at 140° F., the soda crystals are next added and stirred till dissolved, and the sugar of lead is then added in a coarse powder and stirred for a long time, repeating the stirring from time to time during two or three days. Of these mordants Nos. 1 and 2 are for calico, No. 1 being less suitable for gum colours than No. 2. Nos. 3 and 4 are suitable for muslin.

The two following red liquors are made from acetate of lime:—

Acetate of lime, at 24° Tw.	50	90 galls.
Alum	200	— lbs.
Sulphate of alumina	—	272 lbs.
Ground chalk	12	34 lbs.

To prepare these liquors the acetate of lime is first heated to 140° F., the alum or sulphate of alumina is then added and stirred till dissolved, and the chalk is added by degrees. The mixture is well stirred till nearly cold, let settle, the clear liquid decanted off, and the sediment drained on a woollen filter.

The first of these mixtures gives the deepest red in madder work, and the second is for mixing with black liquor to produce chocolates.

For a "resist" red liquor take—

Water	.	.	.	.	.	1 gallon.
Alum	.	.	.	.	.	5 lbs.
Sugar of lead	.	.	.	.	.	2½ lbs.
Crystals of soda	.	.	.	.	.	$\frac{1}{4}$ lb.

Dissolve the alum and the soda crystals in one portion of the water and the sugar of lead in the other. When dissolved mix, let settle, and draw off the clear.

Muriate of alumina, or chloride of aluminium, is made by dissolving the hydrate of alumina in muriatic acid. It is of little use in practical dyeing or printing. Nitrate of alumina is sometimes used in printing the alizarine colours, which see for its preparation. It is very soluble, deliquescent, and dries up to a gummy mass.

Hyposulphite of alumina has been recommended as a substitute for red liquor, but has not been found to offer any practical advantage, and has never come into general use. It is made by dissolving 9 lbs. 1½ oz. sulphate of alumina, and 10 lbs. 10 ozs. of hyposulphite of lime in water separately, mixing the solutions, letting settle, or filtering through thick flannel and using the clear liquid. Aluminate of soda, otherwise known as *alkaline pink mordant*, is a compound capable of wider applications than it has yet received. It has been found capable of producing in dyeing every effect which can be obtained from alum, and in addition certain others which alum does not yield. It was formerly made

in an impure state by adding caustic soda-lye to a solution of sulphate of alumina or of alum, till the precipitate which appears at first is just redissolved. It may now be bought in a solid and tolerably pure state, containing about 50 per cent. of alumina. It dissolves readily in water, but should be kept as much as possible from contact with the air. It is used by printers as a mordant for pinks, the cloth being afterwards run through a solution of sal-ammoniac, which fixes the alumina on the fibre.

Antimony Mordants.

The double tartrate of antimony and potash, commonly known as tartar emetic, is used to some extent in fixing the aniline colours in conjunction with tannin. Its price and its evil reputation as a poison are difficulties in the way of its more extended use.

A cheaper compound lately used in dyeing is the "oxymuriate" (not oxychloride), or muriate of antimonious oxide, made by dissolving the black sulphuret of antimony in strong boiling muriatic acid. It gives bad results if, as is frequently the case, it is contaminated with iron.

The behaviour of antimony with colouring matters has not yet been sufficiently studied.

Arsenical Mordants.

Arsenic in many cases plays the part of an alterant rather than of a mordant. Its use in certain dung substitutes is referred to elsewhere. Arsenite of soda, along with red liquor, is very frequently used in printing aniline colours upon cotton. The result of the reaction is the production of an insoluble arsenite of alumina which attaches itself to the fibre, and in which the colouring matter is entangled.

White arsenic (arsenious acid) dissolved in glycerine is sometimes used in dyeing and printing.

Arseniate of soda is also used as a "prepare" along with the stannate of soda, for goods to be printed in steam styles.

The use of arsenical compounds, both in the manufacture and application of colours, is much objected to, and in the German Empire is legally prohibited.

Bismuth, as a mordant, seems never to have got beyond the mere experimental stage, and the results obtained have not given general satisfaction.

Chromium Mordants.

Chromium yields two distinct classes of mordants, both of extensive use. In the state of chromic acid, combined with potash or with soda, it plays a very important part along with the woods in dyeing blacks, browns, bottle-greens, olives, and a variety of "sad" colours. There are two chromates of potash, the bichromate, red chromate, bichrome, and sometimes merely chrome, being the most generally employed.

The neutral, yellow chromate, monochromate or yellow chrome (not to be confounded with chrome yellow, which is a chromate of lead, and insoluble in water) has for some reason unknown been neglected in Britain, though in considerable use on the Continent. It may be made for use as wanted by dissolving 151 parts of the red chromate of potash along with 143 parts of clear soda crystals, not effloresced. Its action is milder and more easily regulated than that of the red chromate.

The sesquioxide of chromium dissolved in acids is also coming into use as a mordant, especially in the state of aceto-nitrate of chrome, the preparation of which is described elsewhere. The simple acetate of chrome is also

used, and double tartrate of chrome and potash, sometimes known as the chromo-tartrate of potash.

Chrome-alum, a double sulphate of chromic oxide and of potash, is also employed, though chiefly in woollen dyeing. It is a residual product in the manufacture of artificial alizarine. Chrome alum, it must be remembered, contains no alumina and no chromic acid, and cannot be produced, as some dyers imagine, by mixing bichromate of potash and alum.

Copper Mordants.

Acetate of copper, commonly known as verdigris, is met with of different kinds, the principal of which are the blue and the green. Both these compounds are, or were chiefly imported from the South of France. Verdigris, however, is very commonly made in the liquid state by a process very similar to the preparation of red liquor. In, e.g., a gallon of water at about 160° F., 4 lbs. blue-stone and 4 lbs. sugar of lead are dissolved with frequent stirring. When this is completed the liquid is left to settle and the clear is decanted off for use.

Verdigris is used in printing and dyeing blacks on silks, and on hats; in logwood blues on woollens; in catechu colours, where it acts as an oxidizing agent, in "resists" for dip blues, and in certain steam colours.

Ammoniacal copper is made by dissolving the sulphate or nitrate of copper in water and adding ammonia till the pale blue-green precipitate first formed re-dissolves to a rich violet-coloured liquid, which can only be preserved for any length of time in closed vessels. Cotton padded in the dilute liquid takes a pale green.

Muriate of copper (chloride of copper) is made by mixing solutions of chloride of calcium (muriate of lime) and sulphate of copper, and drawing off the clear liquid. It is less commonly used in Britain than on the Continent.

With us the same effects are produced by means of a mixture of nitrate of copper and sal-ammoniac.

Nitrate of copper is generally met with as a deep blue liquid, marking from 80° to 100° Tw. It may be produced by double decomposition of sulphate of copper and nitrate of lead, or by dissolving scrap copper in nitric acid. It is generally sold by workers in metals who use nitric acid in cleansing articles of copper, brass, bronze, &c., and who dispose of the resulting solution as a waste product, sometimes polluted with zinc, iron, lead, &c.

It may be tested as follows:—Add ammonia in large excess; if anything remains undissolved it will probably be either lead or iron. If a portion of the nitrate of copper is mixed with a little pure muriatic acid and a current of sulphuretted hydrogen passed through it, the whole of the fixed matter except zinc and iron will be precipitated. If on filtering the mixture and evaporating the clear liquid to dryness anything remains, it will probably be one of these two metals.

Sulphate of copper, otherwise known as blue-stone (not stone blue), blue vitriol, Roman vitriol, Cyprus vitriol, and, when contaminated with varying proportions of the sulphate of iron, as Admont vitriol, Salzburg vitriol, Baireuth vitriol, &c., is now made direct from the ore. It forms blue hard crystals which contain 32 per cent. of oxide of copper, lose their crystalline water if heated for some time to a little above 212° F., and fall to a white powder. Blue-stone dissolves in three times its weight of cold water, and in half its weight of boiling water. The principal impurity met with in blue-stone is copperas, sulphate of iron. For its detection a little of a solution of the sample is boiled with a few drops of nitric acid, and then mixed with a large excess of ammonia. The copper dissolves to a deep violet-blue liquid, whilst the iron, if any, floats about in reddish-brown flakes.

Blue-stone is used in woollen dyeing, and in "resists" for dip-blues.

The compounds of copper have an oxidizing action. They take up oxygen from the air and hand it over to any organic matter with which they are in contact. This is the principle of the action of blue-stone, or preferably of the sulphuret of copper in printing and dyeing aniline blacks. Hence, too, they act in many cases as colour-destroyers. Where copper is not especially required it should be carefully avoided. A little of a salt of copper put in the indigo-vat gradually oxidizes the reduced (white) indigo present, converts it into the ordinary blue, insoluble state, and of course renders it incapable of dyeing. The same principle explains the action of salts of copper in "resists" in indigo-blue styles.

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Iron Mordants.

The compounds of iron play a very important part in dyeing and printing processes, chiefly for the production of the darker and sadder shades—blacks, browns, olives, chocolates, curtain blues and violets, &c. They are much better applicable to cotton and silk than to wool.

The iron compound most commonly used in printing is the acetate or pyrolignite, known more generally as black liquor, iron-liquor, or sometimes confusingly as black-iron.

Black liquor as commonly met with in commerce has a specific gravity ranging from 18° Tw. to 28° Tw. It has an olive-colour, a peculiar tar-like smell, and an inky taste. It is sometimes made by mixing together solutions of the acetate of lime, or of brown sugar of lead, and of copperas, and after letting the mixture stand to settle, drawing off the clear for use.

More frequently crude acetic acid is allowed to stand upon scrap-iron in large casks or tanks, and is successively run from one such tank into another, till it has dissolved all the iron that it is capable of taking up. Purified acetic

acid does not yield as serviceable a black liquor as that which contains a certain proportion of tarry impurities.

Solutions of arsenious acid are sometimes recommended as a useful addition. It will be remembered that the iron in black liquor is in the state of protoxide (ferrous oxide); a peracetate of iron (ferric acetate) has been proposed, but has not come into practical use.

Black iron is used in madder (alizarine) work to produce colours ranging from purple to black. Mixed with red liquor in various proportions it yields also with alizarine, shades of chocolate, &c. Black liquor is also extensively used with other dye wares.

The hyposulphite of iron and the pyrophosphate of iron dissolved in ammonia, have both been warmly recommended by eminent men as substitutes for black liquor. The pyrophosphate is said especially to yield alizarine purples and lilacs of remarkable beauty and purity. But they have not been generally adopted.

Copperas, green vitriol, green copperas, protosulphate of iron or ferrous sulphate, is made on a vast scale from the soft white pyrites known as "brass lumps," and found in the coal deposits. It occurs in the form of pale greenish-blue crystals, containing 25 per cent. of protoxide of iron, and 45 per cent. of water. If carefully heated the water escapes and a white powder remains. It dissolves in one and a half times its weight of cold water, and in one third part of boiling water. On exposure to damp air it turns rusty, *i.e.*, becomes coated with a brown layer of a basic salt of the peroxide of iron (ferric oxide). It undergoes this change the more readily the more free it is from any excess of acid. As a dead, *i.e.*, neutral, copperas is preferred by many consumers, dealers have the habit of dusting the heaps over with lime, or sprinkling with stale urine, which give this appearance at the cost of introducing impurities.

Copperas should be chosen dry, hard, and clean, and of a decided green colour. If it is pasty to the touch, and of

a dull greyish or whitish green, known in the trade as milky, it is probably contaminated with sulphate of alumina. This impurity is often present if bad pyrites have been used, or if the copperas has been crystallized from too strong a solution.

Copperas in its original state is now less used in dyeing than was formerly the case. But it serves for the manufacture of so-called nitrate (nitro-sulphate) of iron, and in the preparation of black liquor.

Dried copperas, *i.e.*, the white powder above mentioned, is sometimes used by dyers under the name calcined copperas. If it has been heated strongly enough to expel, not merely the water, but the sulphuric acid, nothing remains but peroxide of iron (ferric oxide), as an insoluble water, which has no more action than so much sand.

A persulphate of iron (ferric sulphate) or red sulphate is sometimes employed. It is generally made by adding to a solution of copperas half as much sulphuric acid as it already contains, *i.e.*, 18 per cent. oil of vitriol, and heating the mixture, adding from time to time small quantities of nitric acid to peroxidize the iron.

It forms a pale yellow solution.

Muriate of iron (hydrous protochloride of iron or ferrous chloride) may be made by allowing common muriatic acid to dissolve as much scrap-iron as it will take up. The clear liquid is run into carboys, which should be well stoppered, as on exposure to the air it absorbs oxygen and suffers decomposition. It is generally met with as a pale greenish-yellow liquid, marking about 80° Tw. By evaporation it may be obtained in the state of greenish crystals.

A permuriate of iron (nitro-muriate, oxy-muriate, or ferric chloride) may be made by dissolving hydrated peroxide of iron in muriatic acid, or by dissolving scrap-iron in a mixture of nitric and muriatic acids. This compound is of little use.

Nitrate of iron is a name given to a group or class of compounds, differing in their uses and in their composition.

We have nitrates of iron, properly so called, made by dissolving scrap iron in nitric acid. In these no other acid is present, and the iron is all in the state of ferric oxide (peroxide). The liquid obtained is of a bright red colour if diluted, and it is chiefly used for prussian blues upon silks and cotton yarns.

By far the greater part of the nitrate now used is a mixture of the true nitrate and of the persulphate in very variable proportions. Sometimes the iron present is entirely in the state of peroxide (ferric oxide), but in other cases a portion still remains in the state of protoxide (ferrous oxide).

The purposes for which nitrate of iron are used are exceedingly various, and differences of quality are required accordingly. Thus we have so-called "black-irons" (not to be confounded with black liquor). These black irons are used, as the name shows, for dyeing blacks on silks and cottons, in conjunction with logwood or with the astringents, such as sumac, myrobalans, divi-divi, &c. An excellent quality may be made by the following process:—About $\frac{1}{4}$ ton of copperas, dry and clean, and consisting neither of large blocks nor of small powder, is put in a sound, roomy cask. Upon it are poured 120 lbs. weight of so-called double aquafortis at 64° Tw., and the whole is well stirred up, so that no part of the copperas may escape contact with the acid. Torrents of nitrous fumes are given off, and should be carefully avoided. Hence the cask is best placed in a shed with open sides, or under a draught-hood, connected with the chimney-stack. If the operation has been begun in the morning, the mixture must be stirred again at night. The stirring is a matter of some nicety. Quick, sweeping, circular movements should be avoided. The workman should try to turn every part of the copperas over with the end of his pole, spreading it out where it lies thickest, and working as if he were feeling or groping for some lost article. The next morning, the next night, and the third morning the

stirring is repeated, and by the third evening the process will be completed, and the copperas will be entirely taken up, or at most a few pounds may remain undissolved. Water is then run into the cask, and the whole stirred up, till the product marks 50° Tw., if for dyeing, or 80° Tw. if for printing. The liquid should be clear and bright, free from cloudiness, and of a deep brownish-red colour. A small proportion of the iron will exist in the state of proto-sulphate if any copperas has escaped the action of the acid and has merely been dissolved as such by the water added at the close of the process. The presence of this small proportion of a protosalt is not a disadvantage. A pure persalt of iron with the astringents is apt to produce a black verging too much upon a brown. The protosalts of iron give a more blueish black, so thus a mixture of the two gives a true jet tone.

In "black irons" the presence of any excess of acid should be carefully avoided, as it gives the shades produced an undesirable reddish tone, and over tenders the goods. This is especially the case in warp-printing, as the yarns are rarely rinsed immediately after printing, and if the nitrate of iron is not thoroughly "dead" they may not be able to bear weaving.

If the nitric acid has been overloaded with iron, "over-killed," mischief of a different kind ensues. Oxide of iron is apt to be deposited on the fibre in irregular patches, without being properly combined with the astringent matter, thus producing rusty stains and streaks—a result particularly to be dreaded in piece-dyeing. For blacks, as a general rule, a nitro-sulphate made from copperas, such as the above, is preferable to a true nitrate of iron made from scrap iron.

To lessen the danger of "tendering" the fibre, brown sugar of lead is sometimes added to black iron in very various proportions, but not exceeding 90 lbs. for 138 lbs. of the copperas which has been used. Double decomposition ensues; the sulphuric acid present combines with its

equivalent of the lead, forming a white precipitate of sulphate of lead, and the acetic acid combines with the oxide of iron in its stead. When this expedient is used the sulphuric acid is not only much reduced but no free nitric acid is likely to be present. The only objection to such aceto-nitrates of iron is the increased cost.

Burling iron is a variety of nitrate of iron for blacks for the following purpose. Wool very often contains small fragments of vegetable matter which do not get removed in the process of the manufacture of cloth. If such cloths are dyed in the piece they consequently appear speckled, as the dyes intended for the wool do not "take" upon these portions of vegetable tissue, and hence greyish spots remain, particularly unsightly in black cloths. If these spots are numerous, the entire piece is often submitted to a complete process of cotton-dyeing with nitrate of iron and myrobalans, &c. The margin between a too "sharp" and a too dead condition of the nitrate of iron used is here very narrow. The aceto-nitrate of iron is here generally found the safest.

So-called "common" or "saddening" irons are used for saddening, *i.e.*, darkening certain mixed colours, such as olives, drabs, browns, &c. These nitrates of iron may be "sharper" than the black irons, since the oxide of iron must be deposited slowly and very permanently upon the fibre, as a subsequent treatment with alum, tin spirits, &c., is often needful, the action of which would discharge a loose colour.

The process given above for a black iron, if slightly modified, gives a good saddening iron for most shades. The proportion of nitric acid for 5 cwt. copperas is raised from 120 to 130 or 135 lbs. If any copperas is left unacted upon, it is not dissolved by the addition of water, but the clear liquid is drawn off into a separate cask, and is then let down with water to the strength required.

For drabs a different mixture is preferred. Double

aquafortis is let down with water to about 34° Tw., and 100 lbs. of it is put in a large earthenware pan. In it 4 lbs. of clean iron clippings are dissolved, and then copperas is gradually added as long as it is taken up. The usual quantity dissolved by the above weight of acid is about $\frac{3}{4}$ cwt. When the action is over it is let down with water to 60° Tw.

The last class of nitrate of iron are the so-called blue-irons;—those used for dyeing prussian blues upon cotton and silk with the yellow and red prussiates of potash (ferro- and ferri-cyanides). Prussian blues are now so very largely superseded by the coal-tar blues, that these blue irons are now of much less importance than was the case twenty years ago.

For cotton yarns and cotton piece goods, the receipt first given for a black iron will prove satisfactory if the nitric acid for $\frac{1}{4}$ ton of copperas is increased to 130 lbs. Blue irons may be sharper than black irons, since any free acid that may be present is neutralized by the alkali of the prussiates, and because the blue colour to be produced is not, like blacks, injured by the presence of acids.

For pale blues upon silks, or for blues which have to be converted into greens, many dyers prefer a blue iron made from the metal in the following manner:—

Double aquafortis (64° Tw.) is let down with water to half-strength. A quantity of this is put in a stoneware bowl, and clippings of clean sheet iron are added so long as they dissolve rapidly with the escape of reddish vapours. The finished product should stand at about 43° or 44° Tw.

If iron is still added after the escape of orange vapours has ceased, the product will be mainly a yellowish mud, of no use in dyeing.

Iron filings or turnings, and rusty or greasy iron must not be used.

For deeper and richer shades of blue, either of the two following blue-irons may be taken.

a. Nitrate of soda, refined . . .	24 lbs.
Oil of vitriol	20 lbs.
Water	15 gallons.

Scrap iron as required.

b. Nitrate of soda	16 lbs.
Oil of vitriol	20 lbs.
Cold water	13 gallons.

Scrap iron as required.

In either case the nitrate of soda is first dissolved in the water, and the oil of vitriol and the iron are added by degrees. A brisk action must be kept up, but the heat should not be let become excessive. These preparations should not be made in very large quantities at a time, as they do not keep well. The nitrate of soda used should be free from common salt (chloride of sodium).

In dyeing a blue on the cotton warps of mixed piece-goods, no nitrate of iron made from copperas should be used, as it somewhat stains the worsted, which, as is now almost invariably the case, will have been dyed with an aniline blue.

In all cases the addition of muriatic acid or of any muriate (chloride) must be avoided in nitrates of iron for dyeing black, blue, &c., on the cotton warps of mixed piece-goods. Such admixtures invariably stain and dull the woollen or worsted.

As regards ascertaining the quality of a sample of nitrate of iron, analytical methods are only of subordinate value, since they throw no light on the purity, brightness, fastness, and evenness of the shades that will be produced. If it is required to find the relative acidity of two samples, they are brought to the same specific gravity by adding water to the stronger, and noting the quantity required. A half-ounce measure of each is taken, and into each is run from a burette a normal solution of soda, stirring continually, till the liquid is rendered perfectly neutral to test-

paper. The number of degrees of soda consumed in each case gives the relative acidity.

If it is desired to ascertain whether any of the iron present in a sample is in the state of protoxide, or if the whole has been converted into peroxide, a solution of carbonate of soda is very carefully and slowly dropped in. If any protoxide is present the precipitate produced will be in part at least greenish or olive-coloured, but if the sample is perfectly peroxidized it will be entirely and purely yellow. Or a little solution of red prussiate may be added to a portion of the sample, much diluted with water. The appearance of a blue precipitate shows the existence of protoxide of iron, generally unconverted copperas.

To recognize alumina, a portion of the sample is boiled with a mixture of nitric and muriatic acids, so as to insure that no protoxide remains in the solution. To the clear liquid there is then added an excess of a solution of absolutely pure caustic soda, and the mixture is boiled in a vessel of clean iron—not tinned, “galvanized,” or lined with enamel—and filtered. To the clear filtrate there is added a solution of sal-ammoniac. If any sulphate or other salt of alumina is present, a white precipitate will appear. Alumina in any soluble form is a very objectionable impurity in nitrate of iron. It reddens blacks, and weakens blue shades.

It is sometimes useful to know how a given sample of nitrate of iron has been got up. If a portion is diluted with water, mixed with pure hydrochloric acid, and tested with chloride of barium in the usual manner, the absence of a plentiful white precipitate shows that the sample has been made, not from copperas, but from metallic iron and aquafortis. A *slight* white precipitate or turbidity may, however, be expected in such cases, since the aquafortis is rarely absolutely free from traces of sulphuric acid.

To ascertain if nitrate of soda, sulphate of soda, or common salt is present, add to a small quantity a decided excess of the hydrosulphate of ammonia. All the iron and

alumina, if any is present, will be precipitated. The solution is filtered, the clear liquid evaporated to dryness, and the residue heated to redness in a clean iron spoon. If anything remains, some salt of soda or potash has found its way into the sample.

To detect muriatic acid or soluble chlorides (muriates) dilute a portion with pure water, add a little pure nitric acid, and test with nitrate of silver. If a white, curdy precipitate appears, one of the above-mentioned bodies is present. If the last experiment showed the presence of a fixed alkaline salt, common salt or impure nitrate of soda has been introduced. If there is no such fixed body, the impurity is muriatic acid.

The practical value of different samples of nitrate of iron is best judged by dyeing with them upon a small scale. Equal weights of clean white cotton yarn, or swatches of white calico, are let steep for some fixed time in a decoction of logwood, sumac, &c., taken out, and allowed to drain. They are then immersed in the different samples of nitrate of iron to be compared, which must be diluted to some fixed and uniform strength, say 4° Tw. After steeping for about a quarter of an hour, the yarns or swatches of cloth are taken out, rinsed through cold water, dried, and examined for depth and purity of colour.

Lead Mordants.

The claim of the preparations of lead to rank as true mordants, except in certain peculiar cases, is doubtful, though they play an important part in various dyeing and printing operations.

Sugar of lead, or acetate of lead, is met with in trade in two forms, the brown and the white—the former containing a variety of impurities in the shape of tarry matters. The basic acetate of lead, called also subacetate

of lead, and by the Germans *Blei-essig*—i.e., lead vinegar—is generally prepared when wanted, by adding to a solution of the ordinary sugar of lead a quantity of litharge (better, of freshly precipitated oxide of lead), and letting them stand together with occasional stirring, but avoiding the access of air as much as possible. The clear liquid is poured off, and preserved for use in stoppered bottles.

Sugar of lead, and still more the basic acetate, have a great power of combining with vegetable colouring matters. If added to the decoctions of dye-wares, the sub-acetate throws down the colours, leaving the liquid quite clear. No useful pigments can be prepared in this manner. The lead lakes are dull and deficient in depth, because other matters are precipitated along with the colouring principles.

Sugar of lead has been used as a mordant for saffranine, eosine, and other coal-tar colours. For this purpose, it is open to the serious defect of becoming blackened if exposed to the fumes of sulphuretted hydrogen. Consequently, goods dyed or printed by this means are not permanent, if they come in contact with common lighting gas, sewer gases, the fumes from putrescent animal or vegetable matter, from many chemical works, &c.

The sulphur present in wool itself is liable to blacken lead, especially if the goods have been treated with any alkaline preparation. It becomes a practical question how far this blackening tendency may be overcome by adding to the printing colour, wherever admissible, small proportions of a salt of cadmium, which has a stronger affinity for sulphur than has lead, and forms with it not a black, but a yellow compound, which in certain colours would be much less objectionable.

The affinity of lead for cotton, linen, &c., is not very decided.

Nitrate of lead may be prepared by grinding up a good quality of galena (native sulphuret of lead), free from iron

and copper in aquafortis at about 40° to 50° Tw. When the acid is saturated the clear liquid is drawn off from the sediment of silica and sulphur, and left to crystallize. It may also be made from the native carbonate of lead, so-called white-lead spar. More generally it is obtained from litharge dissolved to saturation in nitric acid.

Its direct uses in dyeing and printing are limited. It served in fixing murexide purple, a colour which is now abandoned.

The oxides of lead, litharge, and red lead can be dissolved in caustic soda, forming compounds known respectively as the plumbite and plumbate of soda. They serve for fixing chrome yellows and oranges upon vegetable fibre, working alternately in chromate of potash and in the plumbite or plumbate of soda.

They have been proposed as substitutes for the stannates, for which they are utterly unfit.

Manganese Mordants.

Manganese has a very powerful affinity for animal and vegetable fibre. If wool, cotton, &c., is steeped in the solution of permanganate of potash it becomes firmly and evenly coated with a deposit of the dark brown hydrated peroxide of manganese. The darkness of the shade thus produced renders these properties useless. But if the yarn or cloth thus mordanted is passed into a concentrated solution of tin crystals, the manganese still adhering to the fibre is reduced to the hydrated protoxide (manganous oxide), which is white, and may then become the medium for fixing light and bright colours upon the fibre.

The use of certain salts of manganese in the so-called bronze styles (*bistre*) is spoken of elsewhere.

Mercury Mordants.

Corrosive sublimate, the perchloride, bichloride of mercury, or mercuric chloride is not now employed as a mordant. It is not merely affected by sulphur fumes, but is acted on by light and by the contact of organic matter.

Tin Mordants.

No mordants are more important or more widely used than those prepared from tin. We have in the first place those containing tin in its lowest stage of oxidation, or as a corresponding chlorine compound. Of these preparations, the most important is the solid protochloride or muriate, more correctly named stannous chloride, but known in the trade as tin crystals, and sometimes tin salts. This substance is made on the large scale by dissolving granulated tin of the best quality in muriatic acid, which should be free from iron, arsenic, sulphuric and sulphurous acid, and other impurities. Heat is applied to the mixture; and when the acid is saturated, the liquid is run off, and allowed to crystallize. The crystals form fine needle-like particles, white, and of a silky lustre. They attract moisture from the air, and should therefore be kept in a dry place, and be well covered. Tin crystals should dissolve in ten times their weight of water, without any turbidity; and if this solution is mixed with a few drops of pure muriatic acid, and with a solution of chloride of barium, no white precipitate should appear. Such a precipitate is a proof of the presence of sulphuric acid as such, or as a soluble sulphate. The former impurity is generally slight, and is due to the traces of sulphuric acid present in most samples of commercial muriatic acid. Soluble sulphates, i.e., those of zinc and of magnesia, may be present in quantity, especially at times when the price of tin is high. Tin crystals ought to contain 52 per cent. of metallic tin;

but as many otherwise pure samples contain moisture over and above the water of crystallization, the actual proportion will rarely exceed 50 per cent.

To determine the exact quantity of tin present in a sample, a standard solution of tin is first prepared by weighing out exactly 500 grains of pure tin, dissolving it in pure muriatic acid in a glass vessel, with the aid of heat, and making the liquid up to the exact measure of 20 fluid ounces.

A standard solution of iodine is then made ready as follows: Weigh out 180 grains pure iodide of potassium and 127 grains of pure iodine, and dissolve them in 10,000 grain measures of cold water. This liquid is kept in small bottles, with well-fitting stoppers.

The relative value of the solution of iodine is next found as follows: A part of the above-mentioned tin solution, such as will contain exactly 2 or 4 grains of metallic tin, *i.e.*, 40 or 80 grain measures, is placed in a beaker; some double tartrate of potash and soda (Rochelle salt) is added to prevent turbidity, and bicarbonate of soda, till the solution is slightly alkaline. A little freshly prepared starch liquor is added, and the solution of iodine is dropped in from a burette, till a slight, but permanent, blue colour is produced in the liquid. The number of degrees of the burette which have been taken up show what measure of the iodine solution corresponds to 1 grain of tin.

A portion of the sample of tin crystals in question, *e.g.*, 5 grains, is accurately weighed out, dissolved in cold distilled water, to which a drop or two of pure muriatic acid is then added. The Rochelle salt and the bicarbonate of soda are then added as above directed, followed by the starch liquid, and the standard solution of iodine is carefully dropped in, stirring from time to time, till the faint permanent blue tinge appears. From the degrees of the burette consumed it is easy to calculate how much actual tin was present in the portion weighed off.

Tin crystals are of extensive use. They are not merely

employed directly in dyeing and printing processes, but they serve in making up compound tin mordants.

Muriates of tin differ from tin crystals merely in being liquid, and in containing proportionately less tin and more acid and water. They are made exactly in the same manner; but as soon as the requisite strength is reached, the liquid is run off and bottled, instead of being concentrated to the crystallizing point.

So-called single muriate is of the specific gravity 40° to 60° Tw., and contains about 1 to 2 ozs. tin per lb. It is used in wool-dyeing, though generally in a mixture, and under some other name.

Double muriate marks from 70° to 120° Tw., and even upwards, and should contain from $2\frac{1}{2}$ to $5\frac{1}{2}$ ozs. tin per lb. The mere specific gravity of double muriate, and, indeed, of other tin preparations, is a very imperfect key to their actual value: that is, if the maker starts with his muriatic acid at 32° to 33° Tw., a smaller proportion of tin will be needed to yield a double muriate at, say, 80° Tw., than if he had at the outset—as is done in some establishments—first let down his muriatic acid to 24° or 25° Tw. with water.

The muriates are liable to the same impurities as tin crystals, and are tested in the same manner. Sulphuric acid is often found in double muriate to a considerable extent. This is reprehensible, as if the dyer requires sulphuric acid for any particular purpose in admixture with muriate of tin, he had much better add it himself in a known quantity.

The more concentrated qualities of double muriate are used in cotton dyeing, and the weaker kinds in wool dyeing, where a larger proportion of acid is admissible.

Some writers commit the curious mistake of considering double muriate of tin as synonymous with the bichloride, perchloride, &c.

These muriates of tin—all, be it remembered, *stannous* salts—serve as the basis of certain compound mordants, or “spirits” as they are generally called.

The following are examples of some of the most generally used:—

Purple, Plum, or Puce Spirit.

Muriate of tin, 70° Tw.	2 galls.
Let down oil of vitriol with water till the mixture marks 28° Tw., and when cold add .	1 gall.
Stir well together.	

Oxalate of Tin, sometimes named "Ox Tin."

A true oxalate of tin is not known in trade, but the name is given to mixtures of muriate of tin with sulphuric acid and oxalic acid, or oxalate of potash. A preparation of this kind may be made from the plum spirit above mentioned by adding 1 oz. oxalic acid, first dissolved in hot water, per gallon.

These preparations are exclusively used in wool dyeing.

Scarlet Spirit.

For cochineal and lac scarlets upon woollen and worsted goods the following is one of the many preparations which have been in successful use. Some dyers apply it at once along with the cochineal or lac, &c., whilst others first "ground" with another preparation to be mentioned below (bowl spirits), and merely top, raise, or finish with the following spirit:—

Muriate of tin, at 54° Tw.	3 quarts.
Oxalic acid	$\frac{1}{4}$ lb.

(Previously dissolved in hot water enough to reduce the whole to 40° Tw.)

Here again many modifications occur in practice. Some dyers hold that superior work is obtained by substituting tartaric acid for half or for the whole of the oxalic acid as here directed. If the goods to be dyed are of a soft cha-

racter, the strength of the murate of tin may be increased to 60° or 70° Tw.

The decline of the cochineal colours renders it needless to enter further into this subject.

Yellow and Orange Spirit.

Double muriate of tin, at 80° Tw.	59 ozs.
Oil of vitriol	2 lbs
Water	2 lbs.

Mixed and let cool before adding to the double muriate.

So-called "claret spirits" are sometimes pure muriate of tin at different strengths, and sometimes contain a considerable proportion of sulphuric acid.

A sulphate of tin can scarcely be said to have a practical existence. Some makers of mordants dissolve feathered tin in a mixture of sulphuric and muriatic acid, and some dyers maintain that with "spirits" thus prepared they can obtain better results than if the tin were first dissolved merely in muriatic acid and the sulphuric acid added afterwards. Other dyers take the opposite view.

With the exception of tin crystals and of the stronger grades of double muriate, the above-mentioned preparations of tin—all, be it remembered, consisting of the protochloride—are used almost exclusively in wool dyeing. Since the brighter and purer colours are now so largely produced by means of the coal-tar dyes, the importance of these "spirits" has much diminished.

The stannic compounds of tin (perchlorides, permuriates, oxy-muriates, nitro-muriates) are produced by a variety of processes, which, however, may in principle be reduced to two. The simpler and more rational of these—much used upon the Continent—is to pass chlorine gas into a solution of tin crystals in water till a little of the solution, mixed with a solution of corrosive sublimate, no longer gives a white precipitate which blackens on stand-

ing. If sufficiently concentrated it solidifies, but readily attracts moisture if exposed to the air. This substance—known by some dyers as “composition”—may be let down with water to any required strength, and used either alone as a per-muriate or oxy-muriate, or may be mixed as desirable with a solution of tin crystals. This method of preparation by means of chlorine is always successful, and never involves loss of the materials.

The process for making per-muriate of tin, which has been generally adopted in England, requires the use of aquafortis, *i.e.*, nitric acid at about 64°—65° Tw. Either—

(a) Tin crystals are dissolved in more or less muriatic acid, heat applied, and nitric acid added from time to time in small portions till the protochloride is entirely converted into perchloride, as shown by the corrosive sublimate test; or—

(b) Metallic tin is dissolved in a mixture of nitric and muriatic acids in different proportions. This is a process which requires some judgment and experience to perform rightly. If the chemical action of the acids upon the metal is not sufficiently brisk, a part of the tin, more or less, may remain in the state of protochloride (ordinary muriate), and consequently two successive lots, made with the same weights of the same materials, may give different tones of colour with one and the same dye-ware.

If the action is too brisk and the temperature rises too high, the result is “firing,” the tin instead of dissolving being thrown down to the bottom of the vessel in an insoluble state.

Even if this extreme condition is not reached, still, if the temperature has been a little too high, the spirit produced may be practically without value. It may contain, on analysis, the correct percentage of tin, and in relative acidity, specific gravity, colour, &c., it may agree with a good sample, yet instead of becoming deposited on the fibre evenly and plentifully, it may refuse to attach itself. Goods mordanted with such a spirit never dye up an

even, well-nourished shade, but come up meagre and irregular.

Where nitric acid is used it is rarely, if ever, entirely expelled, and exerts, doubtless, an influence which may in some cases be beneficial.

Mordants of the perchloride of tin, however prepared, are used principally in cotton and silk-dyeing, their applications in woollen dyeing being much less numerous.

Formulae for preparing some of the principal of these spirits are here given:—

Crimson Cotton Spirits.

Muriatic acid, at 33° Tw.		7 galls.
Aquafortis, at 64° Tw.		1 „
Water		1 „

Put the liquids in a stoneware, jar-shaped pan with upright sides, rather narrower at bottom than at top. Pour in the water first, then the muriatic acid, and lastly the nitric acid—an arrangement which facilitates perfect mixture. Stir well with a glass or stoneware rod, and let stand for about ten minutes.

Meantime weigh out 6 lbs. of grain-bar tin, which is not to be feathered or granulated as in making tin crystals or double muriate. Put in about six rods in an upright position, arranging them at equal distances round the sides of the vessel. As these dissolve the remainder of the rods must be gradually added. If the weather is hot the number of rods entered at first may be reduced to four or five, whilst in winter as many as eight or nine can be put in at once.

No artificial heat must be applied, and the liquid must never be stirred whilst working. If, however, the action grows too strong, one or more rods may be quietly withdrawn and returned when the heat has somewhat subsided. This is not difficult, as with the proportions above given

the ends of the rods will project a little above the surface of the liquid.

If working rightly, the surface of the liquid will show a very slight creamy froth, but if large bubbles form and throw off orange-coloured fumes, the heat is too great and "firing" is at hand. The process lasts from eight to ten hours, according to the weather. When complete the liquid should be clear, without any sediment, and of a very pale straw colour. If it is perfectly colourless, then, except absolutely pure muriatic acid has been used—which is commercially impracticable—a portion of the tin is still in the state of a protochloride. On standing for a day or two the straw colour appears, beginning at the surface.

As a means of regulating the action according to the temperature the water may be reduced in quantity, and in very severe weather may be omitted altogether. In such cases the usual proportion of water is added to the finished product, so that the strength may be unaltered.

This mordant is used for dyeing wood reds, crimsons, &c., on the cotton warps of mixed goods, and serves for a great variety of colours upon cotton yarns.

No. 2.—Red Cotton Spirits.

Muriatic acid, 32° Tw.		6 galls.
Aquafortis, 64° Tw.		1 "
Water		1 "
Tin		6 lbs.

Dissolve as above.

Recommended for brown and claret warps of mixed piece-goods.

No. 3.—Red Cotton Spirit.

Muriatic acid, 32° Tw.		6 galls.
Aquafortis, 64° Tw.		2 "
Tin		10 lbs.

Great care is here required in working to prevent firing. The larger the proportion of the nitric acid to the muriatic the better the spirit, if properly made, is found to work upon cotton.

As a drawback there is an increase of cost.

No. 4.—Red Cotton Spirit.

Muriatic acid, 35° Tw.	8½ galls.
Aquafortis, 64° Tw.	1½ „

Tin sufficient to bring up the specific gravity to 54° Tw.

When the tin is dissolved, add 1 oz. bichromate of potash.

Barwood Spirit.

Muriatic acid, 32° Tw.	5 galls.
Aquafortis, 64° Tw.	1 „

Tin 1 oz. per lb. of the mixed, or about 5 lbs.

Dissolve as above. This spirit is used in dyeing barwood reds.

Plum Spirit.

Muriatic acid 32° Tw.	6 galls.
Aquafortis 64° Tw.	1 gall.

Tin 1½ oz. per lb. of the mixed acids, or about 8½ lbs.

“Solution” is a name given in certain districts to preparations much resembling the red cotton spirits, and used for similar purposes.

Solution No. 1.

Muriatic acid, 32° Tw.	6 galls.
Aquafortis, 64° Tw.	1½ galls.
Water	1 gall.
Tin	7 lbs.

Work with the same precautions. This spirit serves for cotton-dyeing mixed clarets, browns, &c.

Solution No. 2.

Muriatic acid, 32° Tw.		6	galls.
Aquafortis (single), 32° Tw.		3	galls.
Tin		10½	lbs.

This solution requires very carefully working, and when well made has been serviceable for fixing various aniline colours upon cotton.

Purple Cotton Spirit.

Muriatic acid, 32° Tw.		5	lbs.
Aquafortis, 64° Tw.		1	lb.
Tin		¾	lb.

To every 9 gallons of the solution add 2 ozs. bichromate of potash, dissolved in water.

The following compounds, generally known as "oxy-muriates," are used in printing.

No. 1.

Muriatic acid, 32° Tw.		20	lbs.
Water		2	galls.
Sal-ammoniac		5	lbs.
Tin		10	lbs.

No. 2.

Dissolve 16 lbs. tin crystals in a stoneware bowl, set in a larger vessel of hot water. Add very gradually 20 lbs. aquafortis, 64° Tw.

No. 3.

To 60 lbs. tin crystals, add 1 quart water, and heat in a water or steam bath till dissolved. Add 92 lbs. aquafortis at 60° F. by portions, taking care that the action does not become too violent.

No. 4.

Muriatic acid, 34° Tw.	.	.	.	.	11 lbs.
Aquafortis, 62° Tw.	.	.	.	.	5 lbs.

Dissolve in the mixture 2 lbs. of feathered tin. This preparation is frequently used in spirit styles.

The oxy-muriate No. 2, is employed in "cutting" madder pinks, that is, for reducing the reds in the clearing process down to the bright shade required.

Pink Salt, the double chloride of tin and ammonium, is prepared by mixing saturated solutions of sal-ammoniac and of perchloride of tin (stannic chloride), when the pink salt falls to the bottom of the vessel as a white powdery precipitate; it should contain 70 per cent. of the perchloride of tin, and 30 per cent. of sal-ammoniac. It dissolves in three times its own weight of water at 60° F., and if boiled in a weak solution it is decomposed and the whole of the tin is deposited.

Pink salt is valuable as a solvent for organic colouring matters, and though at present neglected, will doubtless receive important applications in the future.

Besides the compounds of the protochloride and the perchloride of tin and their mixtures, there are certain preparations plainly distinct from either. When made from absolutely pure materials they are of a deep reddish amber colour, which darkens in proportion to the quantity of tin dissolved.

In warm weather they suffer spontaneous decomposition

in little more than twenty-four hours. It is supposed, though without absolute proof, that the tin is present as a sesqui-compound intermediate between the proto- and the persalts. The most important of these mordants is:—

Bowl spirit, otherwise known as “scarlet spirit” or nitrate of tin. It must be remembered that the name scarlet spirit is sometimes also applied to perchloride of tin, and even to protochloride mixed with oxalic or tartaric acids. It is made by dissolving the finest grain-bar tin (the “lamb and flag” brand being very frequently preferred) in a special liquid known as dyer’s aquafortis or single aquafortis. This acid marks only 32° or 33° Tw. It must be perfectly free from sulphuric acid and from any of the lower oxides of nitrogen. But it must contain a certain percentage of muriatic acid or of an alkaline chloride.

To prepare bowl-spirits a weighed or measured quantity of single aquafortis is poured into a large, clean, hemispherical stoneware bowl, and tin is weighed out in the proportion of 2 ozs. per lb. of the acid. The tin is not generally feathered, but used in the rod. If the acid is of an average quality and the weather temperate, four or five rods are laid in the bowl and let dissolve. In the course of about half-an-hour the acid begins to “turn,” taking a peculiar amber colour. When this has happened all difficulty is over, and it is merely necessary to add by degrees the rest of the tin, keeping the action up without letting it become too brisk. No orange fumes should be given off, and the effervescence, if any, should be very trifling. If the starting is mismanaged the acid may remain colourless for two or three hours and then at once grow turbid, without ever taking an amber colour. If too much tin has been added at first, or if the acid is not well made, red fumes are thrown off, and the liquid becomes intensely hot and even boils over. In either case it is utterly useless. In warm weather the number of rods of tin added at first is reduced to two or even one, and in extreme cases the process may

be started with half a handful of feathered tin, very clean and dry. The bowl may also be set in a stream of cold water. In time of frost eight or ten rods may be put in at the beginning. The process is very much easier if from half-a-pint to a pint of bowl-spirit of a former batch is added to the acid before introducing the tin.

The spirit when finished marks from 58° to 66° Tw. and contains about $2\frac{1}{4}$ ozs. metallic tin per lb. In winter it is tolerably permanent, but in summer it grows opaque in a short time, and deposits a dense yellowish mass, unfit for use.

This spirit was originally employed for grounding cochineal colours upon woollens, but it is an excellent mordant for cottons.

A so-called "purple-spirit" may be made by heating bowl-spirit very gently, and letting it take up more tin till it reaches 80° Tw. It is very unstable.

Aniline Spirit, so-called from its uses, is made with

Single aquafortis, 32° Tw.	5 galls.
Muriatic acid, 32° Tw.	$2\frac{1}{2}$ galls.
Tin, in the rod	12 lbs.

The acids are mixed and about 12 bars of tin are entered at once, working as directed for "red-cotton spirits" till all is taken up. This spirit is of a deep reddish amber, and contains about 2 ozs. tin per lb. of acid. It is very useful in cotton-dyeing.

In all receipts where nitric acid predominates in quantity along with from 10 to 12 per cent. of a chloride the product will be of the same class as the last-mentioned spirits.

There is another class of tin mordants where the tin, or its oxide, plays the part of an acid, in combination with soda or potash.

The most important of these bodies is the stannate of soda, otherwise known as preparing salt, and much used in preparing both cottons and mixed goods for printing in steam styles. It is never now made by dyers or printers

for their own use, so there is no occasion to describe its manufacture. It usually contains, if sold in the hydrated or crystalline state, from 20 to 27 per cent. of water, and is sometimes sophisticated with common salt.

To ascertain the value a weighed portion of the sample is dissolved in water, pure muriatic acid is added till the solution is very slightly acid, and some slips of clear and pure zinc are then added. The tin is thereby deposited in a spongy metallic state; it is collected, washed, dissolved in a little pure muriatic acid, and its quantity is determined as directed under tin crystals.

The specific gravity of the solution of a given weight of the stannate gives no clue to its value.

Certain compound stannates, such as the arsenio-stannates, phospho-stannates, silico-stannates, alumino-stannates, &c., have been proposed as substitutes for the simple stannate, but they do not seem to have possessed any distinct advantage.

Stannate of potash is dearer than the stannate of soda, and having no superiority has been abandoned.

The stannites of soda and potash are made by dissolving the protoxide of tin (stannous oxide) in an alkali. They can scarcely be said to be in practical use.

Tungsten Mordants.

Tungstate of soda has been suggested as a substitute for the stannate of soda as a preparing salt, but with unfavourable results. Chloride of tungsten has been proposed as a mordant for woollen dyeing, but has been again abandoned.

Zinc Mordants.

The salts of zinc have little disposition to attach themselves either to colouring matters or to organic fibres.

Chloride of zinc (muriate of zinc or in some old receipts butter of zinc) serves to prevent colours drying up, on account of its power of attracting moisture from the atmosphere. It serves also to fix the alumina of aluminate of soda (alkaline pink mordant) upon the fibre. It has also been proposed for dyeing sandal-wood scarlets, a colour which has never come into commercial demand.

The acetate of zinc was formerly used in dyeing murexide yellows, a colour now discarded.

Two mordants lately introduced, and not yet thoroughly appreciated, are of an anomalous nature, having nothing of the character of metallic salts. They are useful for cottons, and in certain cases for woollens.

The first of these is silica. Cotton yarns, well worked in a solution of the silicate of soda and then taken through weak sours (sulphuric acid diluted to $1\frac{1}{2}^{\circ}$ or 2° Tw.), take up a number of colours very readily.

Sulphur is another mordant of the same class. It is generally applied by working in a solution of hyposulphite of soda in water at 158° F., to which muriatic acid equal in weight to the hyposulphite has been added. Both these mordants, sulphur and silica, commend themselves to the notice of the student, and will probably be found of wider use than is yet expected.

The so-called organic mordants have little in common with each other.

Under this head we include, firstly, tannin in its various forms. The so-called astringents are a very numerous class of organic bodies, all containing more or less of this principle, to which their efficacy is owing. They include gall-nuts, myrobalans, sumac, divi-divi, pomegranate bark, oak-bark, extracts of chestnut, kino, extract of Canadian hemlock, known in commerce as "tamarac," catechu, and many others.

The finest and most valuable of these are gall-nuts, or nut-galls, an excrescence formed by the puncture of the

gall-fly upon the twigs of certain species of oaks. The best quality, those from Aleppo, contain on an average from 60 to 77 per cent. of tannin. Chinese galls range from 58 to 77 per cent., and Smyrna galls from 33 to 60 per cent. They are preferred to other astringents, inasmuch as the tannin which they contain is not accompanied by much colouring matter. Consequently they can be used in mordanting cottons and silks which are to receive light and bright shades. True Aleppo galls are sometimes blackish grey, greenish and blueish, with white excrescences, and feel heavy. The Chinese galls are irregular in shape, and are studded over with conical knobs or projections. The French, Istrian, Dalmatian, &c., galls are much inferior, and are rarely seen in the English market.

Myrobalans, myrabolans, or myrabolams, sometimes abridged into "myrabs," are produced by *Terminalia Chebula*, an Indian tree. In size and shape they somewhat resemble dried plums, and should be of a pale stone colour, free from black spots and worm-holes, firm and hard. They should ring like fragments of pottery when shaken up, and if crushed under the hammer and moistened they should form a very glutinous paste.

If bought ground, as is generally the case in small establishments, they are sometimes found mixed with wild galls, spoiled sumac, and divi-divi. These impurities are best detected by means of the microscope.

Myrobalans are on an average decidedly stronger than sumac, and are much used for dyeing a full jet black upon the cotton warps of delaines, &c. Many dyers use them in fixing the aniline colours, &c., upon vegetable fibre, as the oily and glutinous principles which they contain, assist the action of the tannin. Divi-divi, livi-divi, or libi-divi, the fruit of a South American tree named *Cæsalpinia coriaria*, is still stronger than myrobalans. It is met with in the shape of pods containing flat seeds of a bright brown colour. Divi-divi dyes excellent blacks upon cotton along

with nitrate or acetate of iron, but the colouring matter which accompanies the tannin renders it of little use for lighter shades. It should in any case be used in the shape of a clear decoction, since if the goods are steeped or worked among the ware, fragments of the ground husks attach themselves to the fibre, where they cling very tenaciously, acting the part of a resist and giving the pieces or yarns a spotty appearance.

Sumac, sumach, or shumach is made of the leaves and stalks of a shrub known as *Rhus cotinus*, cultivated in the countries bordering on the Mediterranean. The finest quality is from Alcamo, in Sicily. When ground to powder it appears green and bright, and the decoction has a smell not unlike tea. The second Sicilian quality is of a more reddish or yellowish tint. The best Spanish growths, such as that of Priego, are of a fawn colour. Very good sumacs are now produced in America.

Sumacs, from whatever source, should be dry, loose, and bright. If caked together they have been at one time wet, and will be found to have lost strength very seriously. If dull they have probably been kept too long.

On burning a weighed quantity to ashes, sand is sometimes found to the extent of 10 per cent.

Sumac is weaker than myrobalans, and, at the same time, generally costs more. It is less used as a mordant in England than upon the Continent, where myrobalans have been slow in coming into general use. Pomegranate bark and the rinds of the fruit are about equal in value to sumac, to which they are preferred in Spain. In England they are rarely used. They yield a very fine rich black.

Extract of chestnut is rarely met with in this country under its own name, but it is sometimes added to extracts of the dye-woods. Tamarac is now to be met with in the English market and dyes good blacks.

Catechu, cutch, and gambir, though rich in tannin, and though much used in cotton dyeing and printing, can scarcely be said to play the part of mordants.

The active principle in all these bodies, tannin, formerly called tannic acid, is, when pure, a whitish powder, of no smell and of an exceedingly astringent taste. It dissolves freely in water, and less readily in alcohol. It is now to be bought in the pure state, and in most delicate operations is preferred to any of the crude astringents, as it never varies in its composition and introduces no colouring or other foreign matter.

As a mordant it is combined in practice with several other agents according to circumstances. It forms a white precipitate with a solution of tartar emetic, and if cotton is worked in solution of tannin and then passed into a bath of tartar emetic, the same precipitate is formed upon the fibre as an insoluble layer which serves to fix certain coal-tar colours.

It is employed also before or after a salt of tin, with which it also unites to form an insoluble compound.

Tannic acid may be used also along with the animal mordants, and with the oily mordants, both of which will be touched upon below.

Tannin, whether in the pure state or in the state of an astringent vegetable matter, when in decoction, or in the presence of a ferment, undergoes a decomposition which renders it useless, or rather hurtful. It is split up into gallic acid and glucose, and then no longer gives a black dye with the salts of iron, and ceases to act as a mordant. This change may be arrested by the presence of small quantities of ferment destroyers, such as the chloride of zinc, or phenol (carbolic acid). The methods for determining the proportion of tannin in dye wares are not quite free from difficulties, and none of them seem equally well adapted to all cases. On no subject do the determinations of eminent authorities differ so widely.

Oil Mordants.

Bodies of this class were first brought into use in the process of Turkey red dyeing, the fatty matter selected being a certain kind of olive oil known as "emulsive oil" (*huile tournante*). It is known by the property that if well beaten or shaken up with water it does not separate out and rise to the surface, but remains for a long time mixed up with the water, in a state of very intimate division.

Methods were gradually discovered of giving this property to oils at pleasure, and that to a greater extent. Thus a free fatty acid, such as the oleic, was added to the oil, or a small proportion of sulphuric acid, which after being well worked up in the oil, was afterwards neutralized with an alkali. Latterly castor oil is completely decomposed by means of sulphuric acid, and the free ricinoleic acid, in combination with an alkali, is sold as "alizarine oil," or "Turkey red oil." A sulpholeic compound obtained in a similar manner, and an acid prepared from resin, the pyroterebic, are also sold, singly or in mixture with the above.

The uses of the so-called "alizarine oil" are extending.

Various oil mixtures have been proposed for use in printing, principally in pigment styles.

Thus resin has been dissolved in linseed oil; shellac has been used in an ammoniacal solution. Copal is sometimes softened in acetone, and then dissolved in the essential oil of lavender. India-rubber dissolved in petroleum and in coal-tar oils has also served as a vehicle for pigment colours.

The difficulties to be overcome in this direction are not merely the inflammable nature of the mixtures, but their tendency to spread and blur the design. These objections have not yet been overcome on a commercial scale.

Soap not unfrequently acts as a mordant. Sometimes

goods are soaped and dyed without rinsing. Sometimes soap is added to the dye-beck, and sometimes the goods are passed from a soap-beck into sours, or the solution of an acid salt, which causes a film of fatty acid to be deposited on the fibre.

Animal Mordants.

These compounds are highly nitrogenous bodies which can be applied to vegetable fibres and there coagulated or otherwise fixed. Hence the tissue becomes superficially converted into animal matter, and can be dyed or printed just like silk or wool.

Their action is consequently quite unlike that of the mordants previously mentioned, since their union with the fibre to be dyed is purely mechanical.

Of these animal mordants the most useful is albumen. This substance is met with in its purest form as white of egg. In countries where eggs are cheap, the whites are carefully dried down to a solid mass at a very gentle heat—say 112° F. It can then be preserved for a very considerable time, and when wanted for use it is re-dissolved in water at about the same temperature, or even lower. It is generally used in the proportion of 1 lb. per quart of water, and is thickened with gum-tragacanth mucilage. It is then ground up very finely with the colour to be fixed, which may be either a pigment, such as Guignet's green, chrome yellow, ultramarine, &c., or one of the coal-tar colours.

After printing, the goods are exposed to a temperature exceeding 160° F. In consequence the albumen is coagulated, *i.e.*, converted into the insoluble modification, in which state it adheres firmly to the fibre and holds the colouring matter locked up in itself. It can then be removed only by the action of strong alkalies, or of acids, *i.e.*, the muriatic, which injure the fibre.

If desired to produce discharge effects upon a colour

fixed with albumen, pepsine or the juice of the papaw-tree (*Carica papaya*) might be printed on suitably thickened, the goods being then exposed to a moist heat of 98° F. Under these circumstances the albumen is rendered soluble by a process very similar to digestion in a living animal, and can afterwards be washed away.

Albumen solutions may be preserved from putrefaction by the addition of small quantities of a bisulphite. It is coagulated by carbolic acid, and the salts of lead and mercury.

Albumen, like all the animal mordants, is much less commonly used in dyeing than in printing. If cotton is to be mordanted, it is worked in water in which the albumen has been dissolved, dried, heated to 160° F., and passed into the colour bath. The shades thus obtained are fast and brilliant, rivalling silks in beauty, but on the commercial scale it is difficult to get them perfectly even. They are also expensive.

Blood albumen is obtained from the serum of the blood of sheep, oxen, &c. In its properties it agrees substantially with egg albumen, but it is not easily freed from the last residue of the colouring matter of the blood. For all except the brightest and most delicate shades it is preferred by reason of its cheapness. It is said that it has recently been perfectly purified, and is consequently undistinguishable from egg albumen.

In using commercial albumens, it is necessary to beware of insoluble matter, which sometimes refuses to amalgamate with the colour to an even paste, and, if not carefully strained out, may cause smearing.

Attempts have been made to obtain albumen from snails, from the roe of fishes, &c.; but the practical difficulties in the way have not been entirely overcome.

Albumen which has become partially insoluble may be restored, if heated, to about 98° F., in water containing $2\frac{1}{2}$ per cent. of muriatic acid and $7\frac{1}{2}$ per cent. of the stomachs of calves or sheep, cut up into shreds, the pep-

sine being the active principle. The solution is filtered after the lapse of thirty-six hours, and neutralized with ammonia.

Caseine, *i.e.*, the curd of milk perfectly freed from fatty matter, is often used as a mordant, under the name of "lactarine." It is dissolved in ammonia, mixed with the colour, thickened, printed, and fixed by steaming. The fixation does not, as in albumen, depend on a process of coagulation, but on the escape of the ammonia.

The colours thus fixed are less fast than if printed with albumen, but the article is cheaper, and the colours are by some good judges considered to work better. It is, however, capricious, the mixed colour sometimes becoming clotty, and spoiling, under circumstances not fully understood. In all cases it is necessary to keep the solution of caseine or the mixed colour as cool as possible.

Vegetable gluten has been used for the same purpose as albumen and caseine, though with no marked advantage.

The whitest kinds of gelatine—in other words, glue—have been used for animalizing cotton goods and in pigment styles. After printing or dyeing, the fixation is effected either by a passage through a solution of tannin, with or without alum, or by ageing, steaming, and passage through a salt of mercury (Lightfoot's patent), generally corrosive sublimate.

Argol, the bitartrate of potash, known also as tartar, and cream of tartar, is a substance very extensively used in dyeing, especially woollens. That it plays an active part in the production of many colours, *e.g.*, the cochineal shades, is admitted, though whether it is rightly termed a mordant is open to discussion. Some maintain that with a decoction of cochineal it forms a small quantity of carmine, by precipitating, a part—and that the finest part—of the colouring matter in solution. Others suppose that it has a modifying action upon the pores of the fibre, enabling them more readily to take up the colour.

There are several grades of this useful substance. Red argol, the deposit from the fermentation of red wines, slightly refined, is used in dyeing dark colours. White argol is the deposit from white wines. The masses taken from the fermenting-tuns are dissolved in boiling water, skimmed, strained, and allowed to crystallize.

All argols and tartars should be free from sulphuric acid and soluble sulphates,—beyond slight traces,—from chlorides and from any notable quantity of lime.

If white argol is still further purified, it is known successively as grey tartar, and white tartar, or tartar crystals.

As the tartars and argols have risen in price since the destruction among the vines caused by the Oidium, the Phylloxera, &c., a variety of substitutes have been introduced under such names as pro-argol, pro-tartar, tartar substitute, liquid tartar, essence of tartar, &c.

These mixtures contain genuine argol in different proportions, along with alum, common salt, alkaline sulphates and bisulphates, oxalic and acetic acids.

Lactic acid and the lactates have been proposed as substitutes for tartaric acid and the tartrates, though not with any marked success.

"*Alterants*" is a name given to bodies, which, without taking any marked part in promoting the attachment of the dye to the fibre, modify its nature generally, so as to make it brighter and more beautiful. In this respect they agree very closely with

Raising Agents.

Both in dyeing and printing—chiefly as regards madder work in the latter—after the colour has been fixed upon the fibre or tissue, it is submitted to a final process known as "raising," blooming, brightening (French *avivage*, German *schoenen*). This is effected in very different manners,

according to the nature of the case. Sometimes the goods are taken through a weak acid, or a weak solution of a tin mordant. Sometimes, again, as in the case of madder work with the root, successive soapings are applied. In many cases a small quantity of a brighter and more beautiful, though often less fast colour, is either added to the dye-beck towards the close of the operation, or the goods are passed through it in a separate bath.

The process is then generally known as "topping," and is effected by means of magenta, saffranine, the aniline violets, the orchil colours, &c., applied upon a ground got up with the woods, &c. Goods thus "topped" very frequently lose their beauty after a short exposure to air and sunshine.

Levelling Agents.

It is sometimes necessary to add to the dye-beck a body which, instead of promoting the adhesion of the dye to the fibre, has the very opposite effect. There are certain colours which combine so eagerly with the goods to be dyed, that it is difficult to get an even shade, the portions first immersed into the dye liquid taking up more than their share. This is particularly the case in dyeing wool with certain of the aniline colours. To prevent this inconvenience, and to cause the colour to be evenly distributed over the whole surface to be dyed, a quantity of the crystallized sulphate of soda, known otherwise as Glauber's salt, and in many dye-houses as Sally Nixon,—a corruption for *sal enixum*,—is added. This salt diminishes the affinity of the colour for the fibre, so that it is deposited slowly and evenly. Many other neutral salts would have the same effect; but the sulphate of soda is preferred as being cheap, readily procurable, and having little action upon the tone of the dye wares. Upon certain colours, *e.g.*, those of the woods, it acts as a feeble alkali.

GENERAL INSTRUCTIONS ON DYEING.

We will first notice the vessels used to receive and contain the goods to be dyed, the colouring matters, and the water necessary to hold the latter in solution. They are called by a variety of names, as vats (German *kuepe*)—a term generally restricted to indigo work—becks, troughs, pans, kettles, baths, “holes,” cisterns, &c. The material of which they are constructed differs according to the kind of work to be done. For blacks and other dark colours, iron and copper are often employed. For bright or light shades, such as the bulk of the aniline colours, cochineal, and safflower work, &c., block tin is preferable: it is not easily acted upon by such feebly acid and alkaline solutions as are used in dyeing; and if a trace of the metal is dissolved, it is not calculated to deprive the colour of its lustre and purity. Block tin has the further advantage that the dyer, on beginning a fresh lot of goods, can easily see whether the pan is perfectly clean. Its chief defect is the comparatively high expense.

All metal dye-pans can be heated either by an open fire placed beneath, or by means of steam—a steam-jacket enclosing the pan being, in this case, the usual arrangement.

Whether an open fire or steam is preferable is a question on which there is some difference of opinion; but where an exact regulation of heat is essential, *e.g.*, when the temperature has to be gradually raised to a boil within a certain time, or when a given degree of the thermometer must not be exceeded, steam will be found the more convenient.

Wooden dye vessels are much used on the large scale. They are in some cases made of stout staves, held together by hoops, like a cask, an arrangement common for indigo vats, and fitted, for woollen dyeing, with a steam-jacket.

Rectangular troughs and cisterns of wood, made of strong planks, held together with iron bolts and cramps on the outside, are much in use. Heat is applied when needful by blowing steam directly into the liquid. Such wooden vessels, especially if they have been used at a boiling temperature, can seldom be got absolutely clean, as the mordants and dye-wares soak into the wood. Consequently, these dye troughs should be kept as far as possible for the same class of work. It would be ridiculous to dye a log-wood black in a wooden dye-hole one day, and the next to use it for a cochineal scarlet, or a maize shade.

Troughs, tanks, and cisterns of stone are in many respects preferable to those of wood, as they can be much more easily kept clean. They are made of plates of slate or hard grit-stone, joined by means of grooves and acid-proof cements, and stayed with iron bars outside. They are heated by blowing in steam.

The quantity of water required for a dyeing operation is much greater than what is merely needed to dissolve the colouring matters. It must afford free working room, so that the goods do not lie crowded together or doubled upon themselves, but fully spread out. If there is not sufficient room, the shades dyed will be uneven and cloudy, darker in some parts than in others. "A water" is a common expression for the quantity of water needful for a certain weight of goods. Hence to "make up a water" has the same meaning as to "stuff a hole," or to charge a dye-pan with the requisite wares. To boil a cotton cord piece in "two fustics" means to boil it successively in two lots of fustic liquor, each enough for free working.

Dye-vessels of whatever material or shape, except so small as to be portable, are fitted with taps for running in either hot or cold water, and with a large outlet cock or valve for running off spent dye-liquors.

When a bath is charged with the needful water, wares, &c., the introduction of the goods to be dyed is spoken of as "entering" them, and their removal as "lifting." As a

rule, the goods before being entered in the dye-pan require to be thoroughly wetted; without this precaution there is danger of the colour working on irregularly.

It is in most cases necessary that the goods during the process of dyeing should be kept in motion, either from time to time, or constantly. If a skein of yarn were suspended in a dye-pan of any kind and left motionless, the part outside the liquid would remain uncoloured, but that on and a little below the surface would be found more deeply dyed than the rest of the yarn, on the same principle that a drop of some coloured liquid if thrown upon white cloth or blotting-paper and allowed to evaporate leaves a stain, palest in the centre and becoming darker towards the circumference. The means of moving, or, as it is technically called, working or turning the goods, differs according to their mechanical condition. Loose wool, rags, and cotton wool are simply turned about by hand by means of a stout wooden pole. Hanks of yarn and thread, whether of cotton, wool, or silk, if on the small scale, are suspended by means of a wooden rod thrust through them and resting with its ends on the sides of the pan or beck. They are then raised and lowered by hand, and frequently turned, so that the undermost part is raised to the top, &c. Various mechanical arrangements have been introduced for yarn dyeing on the large scale, of which a more regular and constant circulation of the goods in the dye-liquor, or as it is technically called the "flot," is kept up.

For piece-dyeing a variety of arrangements are required. For woollen and worsted piece goods, where the dyeing is done at a boiling temperature, a winch is fixed over the dye-pan. The piece is lowered into the liquid, and when it is entirely unwound the handle is turned in the opposite direction, and the cloth is wound on to the roller again, this alternate process being continued till the shade intended has been reached. At the beginning of the process great speed is required, so that the whole of the piece may, practically speaking, enter the liquid at the same time, and

no portion have the opportunity of absorbing more dye than the rest.

During this whole unwinding and re-winding process, great care must be taken, especially in case of thin goods, that the piece does not get entangled, twisted, or doubled across, as in addition to the risk of tearing the shade dyed would most likely be uneven.

In large establishments the winces are turned by power, the movement being reversed as soon as the piece is entirely unwound. Greater speed is thus obtained, and the man in charge of the beck can give his whole attention to even rolling and unrolling, &c.

In other cases the pieces, instead of entering the dye-vessel perpendicularly and returning in the same direction, are made to travel over rollers fixed in a long cistern beneath the surface of the liquid. The pieces are either fastened together end to end, so as to form an endless chain which circulates in the beck or cistern for a required time, or they simply enter at one end and pass out at the other. The machinery is capable of being regulated so that a piece may move through the liquid at a known speed.

Arrangements of this kind are very extensively used in dyeing cotton piece goods and in calico-printing, where the tissues, after or before the printing in the exact sense of the word, have to be run through some solution, as in the madder style, in the dunging process, &c.

The padding-machine (Klotz-machine, German) is a further modification. Here the pieces not merely travel regularly underneath the liquid, but they are made to pass between rollers covered with an elastic material, so that the colouring-matter, mordant, &c., is forced into the pores of the tissue. "Padding" is very much used in dyeing the cotton warps of mixed piece-goods, in applying the "prepare" to delaines for steam styles, in mordanting with alizarine oil, &c.

One method of insuring regularity in dyeing, especially

in the case of colours which work very readily on to the fibre, is to add the required quantity of dye, not all in one dose at the beginning of the process, but to divide it into portions, or introduce them by degrees. Such precautions are more necessary for wool and silk than for cotton and linen, which take up most colours less readily.

In all cases, when anything has to be added to the dye-beck, the goods must be taken out, "lifted," and not re-entered till the liquid has been thoroughly stirred up so that all parts of it may be equal in strength and composition. No substances should be added in the solid state, except there is ample time for them to become dissolved and mixed before introducing the goods. Dye-wares which have a high tinctorial power, such as the aniline colours, should not only be dissolved in a separate vessel, but should be filtered preferably through fine flannel before adding to the bath. The smallest undissolved particle, *e.g.*, of undissolved magenta, is liable to occasion a very troublesome spot. Extract of indigo is also the better for solution in a separate vessel and filtration before adding to the dye-beck.

Another point to be attended to for insuring evenness is to begin dyeing at a low temperature which is gradually raised to a boil. In many of the dyeing receipts which follow, this precaution is prescribed as necessary. Some of the various dye-wares have to be all boiled up together in the dye-pan at the outset; but in such cases it is mostly necessary to cool (*abschrecken*, Germ.) before entering the goods.

The care taken to bring all portions of the lot of goods dyed at once to the same shade of colour is greater in case of yarns than of loose unspun wool and cotton wool. Any little irregularity of depth in the latter disappears when the fibres are mixed and worked up together in the mechanical operations to which they are next submitted. To such an extent is this the case that grey woollen yarns are often produced by scribbling up together undyed wool with a certain proportion of black and of deep vat blue

wool, and then spinning the mixture. In piece-goods the necessity for perfect evenness is the greatest, since if an error is once made it cannot disappear in any subsequent operation.

As the process of dyeing a lot of goods goes on, little bits of the yarn or small swatches from the end of the piece are from time to time cut off and compared with the pattern. In case of piece-goods, it is often more convenient to fasten loosely to the end or side of the piece some little swatches of the same kind of material for the purpose of examination. In comparing such trial bits with the pattern, the dyer should have the advantage of a north light—the direct rays of the sun being deceptive in comparing colours. He will notice whether the shade is hit, or whether a more prolonged working or the addition of a trifle more of any of the dye-wares is needful. It must be remembered that no two samples of dye-wares can be found exactly equal in strength, and that the appetite for colour, if it may so be expressed, of wools and cottons of different growths and different seasons varies, so that the use of a fixed proportion of ware to a given weight of goods will not always give exactly the same shade. Hence constant watchfulness is needed.

In foggy weather, or in the night, colours may be compared by means of the electric light, which will render great service in dye-works.

In comparing the trial bit with the pattern, they are generally first placed side by side below the eye, and looked down upon, thus judging by reflected light. They are next compared "over-hand," i.e., they are held up to the light, and the eye is directed along the surface, thus catching the light transmitted through a portion of the fibre. A judgment must be formed quickly, as a prolonged gaze at bright colours, *e.g.*, magenta, eosine, cochineal scarlet, &c., fatigues the eye and renders it unable to perceive nice grades of difference.

The essentials in matching-off are a delicate eye for

colour, and judgment based upon experience. The first of these qualifications enables the dyer to observe accurately, whilst the second shows him how to interpret his observations. An outsider, if shown a piece of a cochineal-scarlet cloth may see whether the shade is deep or light, even or uneven, &c.; but an experienced "grain"-dyer will be able to decide whether it has had a deficiency or an excess of mordant, of argol, &c. At the same time he cannot explain in words the indications on which he founds his judgment. Colour-matching, therefore, can only be learnt by practice.

It may be here useful to explain what is really demanded of the dyer. It is very easy, no doubt, to produce upon a small piece of a woollen cloth, *e.g.*, a green colour, there being no precise limitation as to its shade and tone. But the dyer is required, in practice, to get up a green shade which shall be perfectly even, bright, well-nourished, and moreover, which shall neither be lighter nor darker, and shall incline neither more to the yellow nor to the blue than does the pattern supplied. This colour he must be able to produce upon hundreds of pieces or bales of yarn, possibly not all woven or spun from raw material of the same growth.

When the exact shade has been hit, the further treatment of the goods varies. In most cases rinsing in water is required, sometimes at once; at other times not till the goods have had time to cool. With some particular colours rinsing is not admissible at all.

Intermediate rinsings, in the course of a dyeing process are often required, *e.g.*, after the goods have been mordanted, before entering them in the colour-bath, the object being not to introduce into the latter any mordant, &c., which has not become attached to the fibre, but is merely held in a loose state between the threads. Several other operations are resorted to for the same purpose. The goods are left on a roller, or hung up over spar-work, in order to drain; or they are placed in a centrifugal machine and

freed from such useless moisture by "whizzing." Yarns, cotton or woollen, are very often wrung for the same purpose on being transferred from one dye-bath to another, and pieces are squeezed or "nipped" by being passed between a pair of rollers.

It is sometimes necessary before adding either mordants or dye-wares to the water to be used in a dyeing process to "clear it," by letting it boil up in the beck or pan to be used, with a little of the mordant to be employed, and carefully skimming off any impurities which rise to the surface. It need scarcely be said that if the pan is clean and the water pure, no such impurities can collect and the process is needless.

After rinsing follows the final operation, drying. This is generally performed in a room well ventilated, not too copiously lighted, and heated by means of steam pipes. Safflower shades should be dried in the dark, and without any rise of temperature, in a current of cold air.

Where the air is free from smoke, acid fumes, &c., many colours may, in favourable weather, be dried in the open air. This is very generally done with vat blues, cochineal scarlets, &c.

An operation which is not unfrequently required at various stages of dyeing processes is airing, or lieing. The goods are left, sometimes spread out and sometimes in heaps, for a certain time to undergo chemical changes, dependent mainly upon the absorption of oxygen from the atmosphere. This process, in fact, much resembles the "ageing" resorted to in calico-printing.

COTTON DYEING.

The "affinity" of cotton for colouring matters is generally feebler than that of silk or woollen. Few dye-wares

play, with it, the part of substantive colours, *i.e.*, attach themselves to it without a mordant, safflower red and reduced indigo (in the vat), being the best known exceptions. Cotton bears contact with alkalis much better than silk or wool, and is in return much more readily injured by strong acid solutions. Hence it can be dyed by the help of the stannates, plumbates, and aluminates of soda. Containing no sulphur, there is no fear of its blackening preparations of lead, tin, &c. It easily takes oxides of iron, manganese, &c., from their solutions, and can thus be dyed a variety of shades, as browns, bronzes, buffs, blacks, (by treatment with iron and a subsequent passage through an astringent, &c.), prussian blues, copper blueish greens, lead yellows and oranges. These colours, into which, with the exception of the blacks just mentioned, organic matter does not enter, are cheap, easily applied, and very fairly permanent. Prussian blues fade somewhat on exposure to light, but regain their colour in the dark. The lead yellows and oranges (chromates) stand well, unless exposed to the fumes of sulphuretted hydrogen. Manganese bronzes and iron-buffs stand as long as the cloth to which they are applied holds together.

On the other hand, certain organic colours, such as picric acid, the weed-products, *i.e.*, orchil and cudbear, cannot be worked upon cotton without the aid of animal mordants. The aniline colours are fixed upon cotton by means of tannin, alizarine oil, and the mixed mordant of acetate of alumina and arsenite of soda.

Aniline black, however, gives much more satisfactory results upon cottons than upon woollens.

In cotton dyeing the goods are worked in the mordant, as a rule, first, before being immersed in the dye liquids. Cotton is also generally dyed at lower temperatures than wool; often at about 90° to 100° F., and very frequently in the cold.

The most difficult task of the cotton dyer is in the case of the cotton warps of mixed goods, where the warp is

wool or worsted. Here he is required to produce upon a more refractory material, colours so nearly alike in depth, tone, and brightness, to the wool or worsted, that the piece appears uniform and free from anything of a "checky" character.

We now insert a selection of receipts for the production of the principal colours upon cotton wool, cotton yarns and threads, and piece goods, so as to show the scope of this department of the art.

Aniline Black on Cotton Yarn (100 lbs.).

Mix 6 lbs. 9 oz. aniline oil with $8\frac{1}{4}$ lbs. muriatic acid at 32° Tw. Let cool, and add the solution of 4 lbs. 6 ozs. chlorate of potash in 66 parts of water. Then add $43\frac{1}{4}$ pints of chloride of iron at 30° Tw.

The yarns, previously bleached, are placed for 8 to 10 hours in this mixture, which must be previously let down with a sufficient quantity of water at about 100° F. Lift and place the yarns in soda solution at 21° Tw. for half-an-hour to neutralize the excess of acid. Wash and steep for half-an-hour in 33 quarts of water and 7 ozs. chromate of potash at about 112° F. This beck gives the dye more permanence and prevents "greening." Wash and work in the following mixture:—

Alizarine oil	.	.	.	.	$17\frac{1}{2}$ ozs.
Potash	.	.	.	.	2 lbs. 3 ozs.
Water	.	.	.	.	33 quarts.

Dry at once.

This process may be used for linen, hemp, jute, or silk, as well as for cotton, whether in yarns or pieces.

Another Aniline Black.

For each pound of cotton yarn take $3\frac{1}{2}$ of blue-stone dissolved in water, made very feebly acid with muriatic acid. Give seven turns and wring well. Dissolve $\frac{1}{2}$ lb. hyposulphite of soda per gallon water at 120° F., five turns and wash well. Dye cold in chlorate of potash 3 ozs., sal-ammoniac 3 ozs., muriate of aniline $\frac{1}{2}$ lb., in sufficient water, seven turns quickly and wring well. Hang up even at 77° F. for 48 hours, and raise to 84° F. Take through either bichromate or weak soda-lye and wash well. If reddish when dry, take through a very weak chloride of lime water.

Another Aniline Black.

Take 1 lb. muriate of aniline, 6 ozs. chlorate of potash, 4 ozs. blue-stone. Dissolve the aniline salt in $\frac{1}{2}$ gallon boiling water and let cool. Dissolve the chlorate of potash and the blue-stone in the same manner in half a gallon of boiling water, let cool, and mix the two solutions. Dye the cotton in the cold mixture from 15 minutes to $1\frac{1}{2}$ hour. Take out and expose to the air till the colour is a distinct green; pass for five minutes into half a gallon of cold water, with $\frac{1}{2}$ oz. bichromate of potash, and $\frac{1}{8}$ oz. muriatic acid. Air a second time for half-an-hour, and rinse well in cold water. If too brown, work again for a few minutes in the first bath, and air again for about half-an-hour.

Aniline Black with Oil (100 lbs. cotton).

Prepare with alizarine oil. Then make up a water with:—

Muriatic acid	.	.	.	.	.	9 lbs.
Aniline oil	.	.	.	.	.	6 lbs.

Bichromate of potash	12 lbs.
Sulphuric acid	8 lbs.

Work the cotton in this for an hour, raise quickly to 194° F., soap, take through oil again, and dry.

Fast Black (100 lbs.).

Dissolve 24 lbs. extract of logwood in a hot water, add $1\frac{1}{2}$ lb. blue-stone, enter the yarn, give a few turns, and wash. Add to a fresh cold water 2 lbs. bichromate of potash and $1\frac{1}{2}$ lb. nitrate of iron. Take the yarns through this and back again to the first water, to which have been meantime added 2 lbs. soda crystals and the same weight of olive oil.

Black on Cotton Wool (to stand fulling, 60 lbs.).

Extract of logwood	14 lbs.
Extract of bark	$1\frac{1}{2}$ lb.
Blue-stone	4 lbs.

Dissolve at a boil, enter the cotton wool, boil for $1\frac{1}{2}$ hour, and let stop in the liquid over night. Lift, let lie in heaps for two days; enter in a cold water containing copperas, 8 lbs., lixiviated chalk, 2 lbs. Take out after two hours, let lie a day or two, rinse and raise at a hand heat with oil and soap.

Black (11 lbs.).

Dissolve in a water 1 lb. $1\frac{1}{2}$ oz. solid extract of logwood and $1\frac{1}{4}$ oz. extract of bark. Boil the yarn in this liquid till thoroughly saturated. Lift, wring, and enter in a fresh water with 7 ozs. quicklime. Five turns, wring, and enter in a water with 1 lb. $1\frac{1}{2}$ oz. copperas; ten turns and lift.

Into the logwood water are now put $10\frac{1}{4}$ ozs. soda-ash. Enter, give ten turns, lift, and add $3\frac{1}{2}$ ozs. copperas; five turns more, and the dyeing is complete.

It is well to leave the yarn in a heap for six hours after the logwood bath before passing into the lime-water.

Another Black (220 lbs.).

Boil for three hours with 88 lbs. extract of logwood; lift, wring, and dry. Dissolve in a cold water 33 lbs. chromate of potash and $17\frac{1}{2}$ lbs. blue-stone; enter and turn for an hour. Lift and return to the logwood beck at 140° F., after having previously added $17\frac{1}{2}$ lb. soda-ash. Work for two hours and sadden with 11 lbs. copperas.

Blue Black for Sewing Cotton.

Boil the yarn and ground with sumac; mordant, wring out, and run through black liquor at 2° Tw. Raise with clear lime-water and wash in cold water. Sadden with logwood liquor and copperas in the same liquor, and it is then ready for sizing and polishing.

Good Black (60 lbs.).

Boil 12 lbs. cutch with $1\frac{1}{2}$ lb. blue-stone; put the yarn down in this all night; work in the morning in a clear lime-water; then add 6 quarts black liquor to a cold water, give four turns in this; work again in clear lime-water, and wring up. Boil 30 lbs. ground logwood and 6 lbs. fustic, add the decoction to a hot water, work yarns six turns, lift, and add 1 quart black liquor, and wash off with the addition of a little oil and soda-ash if wanted soft.

Another Black (60 lbs.).

Boil 12 lbs. sumac ; steep yarns over-night with the decoction, and work as in the last receipt. If a bluer shade is wanted omit the first lime-water.

Logwood Black (60 lbs.).

Boil 5 lbs. logwood extract and $1\frac{1}{2}$ lb. blue-stone ; put down yarns in this all night, and work the next morning in 6 quarts black liquor in a cold water. Work in a clear lime-water and wring. Then boil 5 lbs. logwood extract, $\frac{1}{2}$ lb. fustic extract, and add to a hot water, work yarns for half an hour, lift, and add 2 lbs. copperas ; wash and dry.

Another Black (60 lbs.).

Boil 6 lbs. logwood extract, $\frac{1}{2}$ lb. fustic extract, and add to a boiling water ; work yarns for an hour, lift and wring. Dissolve 1 lb. chrome (bichromate of potash) and 1 lb. blue-stone, add to a cold water, give four turns, let off and wring ; add 2 lbs. soda crystals to the logwood liquor, give four turns, lift ; add 3 lbs. copperas, four turns more, wash and dry.

Common Black (60 lbs.).

Work in lime-water and wring ; then with 6 quarts black liquor in a cold water and wring. Lime again in a clear lime-water ; boil 24 lbs. ground logwood, add the decoction to a hot water, work five turns, lift, and add 2 lbs. copperas ; five turns more ; wash and dry.

Fast Black (60 lbs.).

Give a good blue ground in the indigo-vat. Then work as in the Logwood black receipt (p. 95).

Black for Sewing Thread (55 lbs.).

Boil out 11 lbs. sumac in water. Steep for a night in the boiling liquid; lift, work for an hour in black liquor at 14° Tw. Lift and hang out five or six hours. Make up a fresh cold water with 17 ozs. lime and $8\frac{1}{4}$ ozs. chromate of potash, and work the thread till it is of a level brown colour. Rinse and dye at 190° F. with 15 lbs. 5 ozs. logwood, working for fifteen minutes. Rinse.

Fast Blue Black on Cloth or Yarn.

Give a ground in the vat, take through vitriol sours, and wash well in cold water. Work the goods in sumac, and then pass into a water with 4 quarts copperas liquor at 10° Tw. Wring and raise with lime-water or bichromate of potash, wash and enter into a logwood bath at 160° F., add 2 quarts copperas water at 10° Tw., and run through again. Wash, and then repeat the process with the logwood and copperas. If not blue enough, add a little blue-stone along with the copperas.

Piece goods require three or four turns, and yarns five or six turns in every operation.

Black on Velveteens.

Run the piece first through boiling logwood liquor (known in some districts as the slop-pan). Pass into a

fresh water, with 1 quart alum-water and 1 quart copperas, each at 6° Tw. Wash and return to the logwood, and pass again into a water with 1 quart alum, 1 quart copperas, and 3 quarts red liquor, and then wash.

After washing the piece is transferred to a logwood-tub, nearly at a boil, holding about 50 gallons, and made up in the proportion of 1 lb. logwood to 3 galls. water. In this the piece is winced for half an hour. From this the piece is brought to a so-called "taking-off tub" of the same size, made up with 2 quarts alum-liquor at 6° Tw., 2 quarts copperas at the same strength, and 3 quarts red liquor. After wincing in this water the piece is lifted, washed, and returned to the logwood-tub, and the former dyeing and taking off repeated. After washing it is worked in logwood for the third time, and "taken off" in a bath of 1 gallon copperas at 6° Tw., and washed. The piece is next brought into a sumac tub, where it is winced as in the logwood, "taken off" in water to which 4 quarts of copperas solution have been added, washed, re-entered in the sumac tub, and again taken off in a bath made up with 2 quarts copperas at 6° Tw., and 2 quarts blue-stone at 8° Tw., and it is then washed in cold water.

The piece is then examined, and if not blue enough, or if of a reddish colour, it is entered in a tub of 50 gallons water and 5 gallons sumac liquor for half an hour at 150° F. It is then "taken off" in water to which from 1 to 2 quarts blue-stone liquor at 8° Tw. have been added. The redder the tint the more sumac will be required, and the more blue-stone. If an excess of these wares is used the piece will show a greenish tint.

If a piece appears green it is generally rejected, and has to be stripped. This process is done as follows: Boil in water, containing 30 lbs. soda-ash to 100 gallons, for two hours, lift, wash, and run through bleach liquor at 2° Tw. Pass into muriatic sours at 1½° Tw. at about 150° F., after which it is well washed and is ready for re-dyeing.

Bright and Very Deep Black.

Boil in a water 8 lbs. solid extract of logwood and 1 lb. extract of bark for half an hour. Dissolve in the liquid 1 lb. blue-stone; enter in the hot liquid and work for an hour; raise to a boil and work for half an hour longer. Make up another hot water with 1 lb. bichromate of potash and 3 lbs. common salt; enter yarns, work well, let cool, and wash. The liquid of the last bath should have a brown colour, but if it appears rather black, a little blue-stone must be added.

Another Bright Black (10 lbs.).

Prepare a water with 1 lb. logwood extract and 5 ozs. fustic extract; boil yarn in this bath for fifteen minutes, and let stand over-night. The next morning lift, wring, enter in a water with $\frac{1}{4}$ lb. bichromate of potash and $1\frac{1}{4}$ lb. blue-stone; work for fifteen minutes, lift and wring. To the first (logwood) bath add 2 ozs. soda crystals; enter and work yarn for half an hour; lift, wring, and return to the bichrome bath, to which $2\frac{1}{2}$ ozs. copperas have been previously added; wring again, and return to the logwood bath for half an hour; lift, wring, and dye without washing. It is finished brighter by taking once more to the logwood-bath, to which has been previously added a mixture made up of 1 oz. olive oil, $\frac{1}{2}$ pint of water, and 1 oz. soda-ash, beaten up to an emulsion.

Blue Black on Cotton Velvets (10 lbs.).

Work in a boiling soda-water, which when cold would mark $2\frac{1}{2}^{\circ}$ Tw. Rinse; steep over-night in the decoction of 2 lbs. sumac; lift, drain, and work for fifteen minutes in

black liquor at $6\frac{1}{4}$ Tw. Work for another fifteen minutes in a cold water, with 1 lb. alum and 1 lb. blue-stone; rinse and dye at 122° F., with 2 lbs. logwood and $\frac{1}{2}$ lb. bark for fifteen to thirty minutes.

To soften the goods take them through an emulsion of $\frac{1}{2}$ lb. olive oil and a solution of $2\frac{1}{2}$ ozs. potash. Dry.

Sumac Black (110 lbs.).

Prepare with 22 lbs. of sumac overnight at a boil; enter in a fresh water with $15\frac{1}{4}$ lbs. copperas and 35 ozs. precipitated chalk. Work cold for an hour, lift, and expose to the air. Make up a fresh water with $6\frac{1}{2}$ lbs. quicklime, and work till the goods are an even brown all over.

Rinse well, and dye in a fresh water at 167° F. with 55 lbs. logwood and 11 lbs. bark. Sadden in the same water with 35 ozs. copperas.

Light Blue on Cotton Wool (50 lbs.).

Steep for some hours in the hot clear decoction of 8 lbs. sumac, lift, drain, and enter in a water at 167° F., containing the clear solution of 4 ozs. Nicholson blue. Work for half an hour, lift, add to the flot 5 lbs. alum previously dissolved; re-enter the cotton wool, and work at 102° F., for half an hour; drain and dry.

Methylene Blue (2 lbs. 3 ozs. piece goods).

Pad in alizarine oil in the proportion of 1 measure oil to 16 measures of condensed steam water; dry and pad again in nitrate of iron, at $1\frac{1}{2}$ Tw.

Dry carefully, avoiding creases. Hang up for two days in the cold, and fix in a solution of silicate of soda at 140°

Fahr., in the proportion of 80 grains silicate to $1\frac{1}{4}$ pint of water.

Wash well, and mordant with

Tannin (pure)		$10\frac{3}{8}$ ozs.
Water		65 pints.

Enter at 86° F., raise in ten minutes to a boil, which is kept up for twenty minutes. Wash, drain in the centrifugal, and dye with methylene blue as follows:—

River water (hard)		175 pints.
Soda-ash		$6\frac{3}{4}$ ozs.
Phosphate of soda		$6\frac{3}{4}$ ozs.
Methylene blue		$1\frac{1}{4}$ oz.

The methylene blue must be previously dissolved in 14 pints distilled water, let settle, and filtered before adding.

Enter at 86° F. and raise gradually to a boil in half an hour. Wash, dry, and calender..

This process gives a deep blue with a coppery reflection and bears soaping well.

For a lighter shade, oil as above, pad in a solution of alum in the proportion of $\frac{3}{4}$ oz. per $1\frac{1}{4}$ pint of water. Dry in the stove, avoiding creases. Hang up for two days in the cold, and fix with

Water at 122° F.		175 pints.
Chalk		$17\frac{1}{2}$ ozs.
Arsenate of soda		$3\frac{1}{2}$ ozs.

Wash, drain in the centrifugal, mordant with tannin, and dye as before.

Methylene Blue (another process).

Work in a solution of tannin, and wring well, take through tartar emetic, and wring again. Pass into a soap water, after which it is washed well. Enter in a cold

water which is gradually raised to a boil, while the dissolved colouring matter is added by degrees.

If a greener tone is required, top with bark liquor; or, if a redder tone is needed, top with a reddish aniline blue, or even with methyl violet.

*Aniline Blue (soluble in spirit) of the Berlin Aktien
Gesellschaft (11 lbs.).*

Boil 35 ozs. sumac, or 2,790 grains tannin in water, filter and dissolve $17\frac{1}{2}$ ozs. curd soap in the clear solution, and enter the cotton over-night in the hot liquid. Wring out and make up a water at $2\frac{1}{2}^{\circ}$ Tw., with red liquor, to which the clear solution of the colour is added according to the shade. Enter the yarn and dye, heating to a boil for some time.

Aniline Blue (100 lbs.).

Alum	8 lbs.
Tartaric acid	$\frac{1}{2}$ lb.
Soda ash	4 lbs.
Aniline cotton blue	14 ozs.

Enter hot, turn for twenty minutes, lift, raise to a boil, re-enter, and dye to shade.

Benzyl Blue.

Prepare with sumac or tannic acid in the usual way. Dissolve the colour in 100 parts of boiling water, and add the requisite quantity to a lukewarm water.

Guernsey Blue (10 lbs.).

Prepare with 2 lbs. sumac ; dye at 88° F. with the solution of 2 lbs. Guernsey blue. Lift, add 1 lb. alum, re-enter, give a few more turns, take out and dry.

Blue Cotton Satin (100 lbs.).

Run for an hour through a hot cistern, made up with 17 ozs. sumac, $6\frac{1}{2}$ ozs. soap, and the same weight of rape oil. Make up a fresh boiling water with $5\frac{1}{2}$ lbs. ground alum, and $6\frac{1}{4}$ ozs. Nicholson blue, and run through this to shade.

For the finishing take, to make up 175 pints, 5 lbs. 7 ozs. gum tragacanth, and dissolve it in water, adding the clear solution of 1 oz. Nicholson blue, and $5\frac{1}{2}$ lbs. alum. Stir into the hot mixture 17 ozs. stearine and 5 lbs. 7 ozs. glycerine. Apply hot, dry, and calender.

Navy Blue (11 lbs.).

Boil 2 lbs. 3 ozs. logwood, and dissolve in the clear, hot decoction 26 ozs. curd soap. Steep the yarn in this liquor for 2 hours at 167° F. Lift, add to the same water 26 ozs. copperas, re-enter yarn, and work till the colour is even. Wash in cold water and work in a fresh water with 17 ozs. curd soap for an hour at 144° F. Make up a boiling water with $2\frac{1}{2}$ ozs. of an aniline blue soluble in spirit, and 2 lbs. 3 ozs. red liquor at 14° Tw. Work the yarn in this at a boil till the shade is obtained, and rinse.

Blue without Indigo (55 lbs.).

Boil with soda, rinse and dry.

Boil 4 lbs. 6 ozs. starch in 11 quarts water, and add after cooling—

Chlorate of potash	.	.	.	10 $\frac{1}{2}$ ozs.
Chloride of copper	.	.	.	20 $\frac{3}{4}$ „
Muriate of aniline	.	.	.	2 lbs. 10 ozs.

Thirty-five ozs. of the cotton are passed five or six times through 17 fluid ozs. of this mixture; another 17 fluid ozs. is then added, and a second 35 ozs. of the cotton passed through, and so on till all is used up. The cotton is then aged by heating in a stove to 100° F., steam being injected from time to time. The starch is then removed by steeping in a water to which 6 lbs. 9 ozs. malt have been added. After a day the cotton is rinsed and taken through weak vitriol sours, and then through a soda-bath at 3° to 4° Tw. A blue-black is thus obtained, which may be turned more to a blue by decreasing the muriate of aniline, chlorate of potash, and chloride of copper by one-third.

Aniline Blue with Manganese Mordant.

Boil yarn with soap and soda, take through a weak solution of permanganate, lift and wring. It has then a pale brown colour. Steep in a solution of tin crystals at 11° Tw. till it is perfectly white. Wash and pass into a sumac water, 1 lb. sumac to 10 lbs. yarn. Make up a water with $\frac{1}{2}$ lb. alum, $\frac{3}{4}$ lb. soda, and 6 drachms (avoirdupois) soluble aniline blue. Heat to 122° F., enter yarns, give five turns, add 1 $\frac{1}{2}$ lb. alum, and 1 $\frac{1}{2}$ oz. of the blue, enter yarn again, give eight turns, rinse and dry.

Topped Vat Blue.

Dye a medium shade in the cold vat, rinse, and enter in a bath of oxy-muriate of tin at $6\frac{1}{4}$ Tw. Steep for half an hour, and pass into a fresh water in which 12 lbs. logwood chips have been boiled for every 50 lbs. yarn, and steep for an hour. Lift, and add 3 lbs. chromate of potash. Re-enter, give four turns, rinse and dry.

Or—

Dye a light blue in the cold vat, and rinse. Make up a water with $\frac{1}{4}$ lb. nitrate of iron, and $1\frac{1}{4}$ lb. tin crystals per 100 lbs. yarn. Enter and work for an hour, wring and enter in a fresh hot logwood beck, and dye to shade.

Vat Blue with a Catechu Ground (10 lbs.).

Boil 1 lb. catechu in water, dissolve 5 ozs. tin crystals in the liquid, and work in this for two hours at 144° F. Squeeze and enter in a beck at 189° F., with $2\frac{1}{2}$ ozs. chromate of potash. Lastly, dye to shade in the cold vat.

*Dark Blue with Vat Ground for Twills and Fustians
(37 lbs.).*

Boil for two hours with 35 ozs. soda-ash, press and rinse. Give a light blue in the cold vat, and take through a water at 122° F., soured with 35 ozs. vitriol, and rinse again.

Make up a cold water with 11 lbs. nitrate of iron, and $3\frac{1}{8}$ ozs. tin crystals. Work for an hour, and dye in a fresh cold water with 11 lbs. logwood and $3\frac{1}{4}$ lbs. alum rinse.

For a darker shade add to the old logwood flot $1\frac{1}{2}$ oz. chromate of potash, enter the goods again, and work for half an hour.

Indigo Dyeing. The Blue Vat.

Indigo, unlike the bulk of dye-wares, is as such insoluble in liquids which the dyer can employ. If treated with sulphuric acid, indeed, it is rendered soluble in water and can be used for dyeing blues on fibres and tissues. But it has undergone a change which very seriously interferes with its most valued property—its fastness.

In order to fix unaltered indigo blue upon the fibre, we take advantage of the circumstance that this indigo blue or indigotine, in the presence of certain agents, is reduced to a white compound (known as indigo-white), which is soluble. Fibres or tissues are then steeped in the solution, taken out and exposed to the air, when the white indigo adhering to their surfaces becomes re-oxidized and remains permanently attached to them as indigo blue.

There are various agents by which indigo can be reduced into the white soluble condition. That generally selected for cotton dyeing is copperas, the sulphate of protoxide of iron (ferrous sulphate) in presence of lime. The copperas, in contact with lime yields hydrated protoxide of iron (ferrous oxide), which greedily absorbs oxygen from any substance with which it comes in contact, and in this way reduces the indigo.

The indigo to be used in setting a vat, is generally first broken up into small fragments, wetted with hot water, and is then ground to a paste in a peculiarly constructed mill. The chief features of this mill are a strong iron cylinder, capable of being made to revolve rapidly on an axle, and smaller, solid, very heavy iron rollers placed within. Sometimes, instead of the rollers, there are three heavy iron globes like cannon-balls. The moistened indigo being introduced, the cylinder is made to rotate by steam-power, and the indigo is ground to a fine, uniform pulp by the action of the rollers or of the balls. It should be reduced to a perfectly creamy paste, quite free from fragments. If

such remain, they generally escape thorough reduction and solution in the vat, and are consequently wasted.

The copperas should be free from salts of the peroxide of iron, and from any sulphate of copper. The latter impurity is very rarely, if ever, found in the best Lancashire, Yorkshire, or Scotch copperas made from the iron pyrites of the coal-beds. If present it acts injuriously by transferring oxygen from the air or the water to the white indigo, and thus re-converting it again into blue indigo, not in the vat, but in the fibre. Malicious workmen have been known to put sulphate of copper into the vats, for the sake of throwing them out of order.

The lime should be of the best quality, recently burnt, fresh slaked and sifted. The dyer in setting his vat should know how much actual dry indigo is contained in a pound of his fine pulp.

The vats are generally made of large slabs of flagstone or slate, well jointed and clamped together, and secured by cement. As the copperas-vat, used for vegetable fibres, is worked in the cold, no heating arrangement is needed.

The size of vats differs. In large establishments they are often 9 feet long and deep by $3\frac{1}{2}$ wide, or $6\frac{1}{2}$ feet long and deep by $3\frac{1}{2}$ wide, and are conveniently arranged in a set (or sets) of ten. In small dye-works wooden tubs are often used.

The proportions of the materials may vary within certain limits. A common proportion is ground indigo 36 lbs., copperas 60 lbs., lime 80 to 87 lbs.; or indigo 30 lbs., copperas 90 lbs., lime 90 lbs. The vat is filled with water, the lime added and well stirred up so as to form a uniform milk of lime. The indigo is next stirred in, and the solution of the copperas is gradually added, still stirring. When the mixture is thoroughly made, the whole is left for some hours, but with occasional stirring. As soon as it turns a yellow with an olive cast, it is ready for use.

The dyeing process is very simple. The yarns or pieces are first wetted out uniformly with water, and then taken

through the weakest, or the most nearly exhausted vat which is on hand, proceeding thence to a stronger and stronger vat till the shade is reached. With piece-goods especially it is of importance that they should enter the vat evenly and uniformly, so that all parts may take up an equal proportion of the liquid, and that as they issue from the vat they should be evenly nipped by means of rollers. Exposure to the air is the next step, for as long a time as the dyeing process itself has lasted, *i.e.*, from five to fifteen minutes. Next, the goods are taken through weak vitriol sour, passed into cold water, and dried.

The *New Indigo Vat* (Schützenberger and De Lalande's Patent) is set as follows:—

A solution of bisulphite of soda at 49° to 59° Tw. is placed in a covered vessel containing zinc clippings, borings, &c., heaped up loosely so as to fill the tank without occupying more than a quarter of its total contents. After these ingredients have remained in contact for an hour the liquid is drawn into a cistern containing milk of lime, which decomposes the zinc salt. The clear liquid is strained off, soda or lime sufficient to dissolve the reduced indigo is added, and the indigo, finely ground as usual, is stirred in. During all this process access of air is avoided as much as possible. In this manner 1 lb. indigo may be dissolved in 1 to 1½ gallons of liquid. The vat is then filled with cold water if for cotton, and with hot water if for wool, and a suitable amount of the indigo solution is added. An excess of the hydrosulphite is always present, whence the blue scum (flurry) formed on the surface by the action of the air on the reduced indigo solution in the ordinary process is almost entirely avoided. The dye thus resists the action of the atmosphere better than the ordinary copperas vat, and is free from the inconvenience of holding in suspension more or less peroxide of iron, lime, carbonate of lime, &c. By adding to the dye-bath from time to time a little concentrated indigo solution, the strength can be maintained at any required point, and thus any given shade

may be got with the smallest number of dips, the tints being brighter than those produced by the old process.

Induline Blue (Williams Brothers and Ekin).

To dissolve the dye, take 10 lbs. of the dry material, $2\frac{1}{2}$ lbs. glacial acetic acid, and 2 gallons methylated spirit. Heat together in a water or steam bath for two or three hours, or until dissolved; then add 8 gallons methylated spirit (cold), and allow the solution to stand for twenty-four hours, and filter.

Mordant for 100 lbs. cotton.

Work in the usual way with 4 lbs. cutch and 2 lbs. bichromate of potash. Wash. Work with the decoction of 4 lbs. sumac, and pass, for medium shades, into a water made up of 1 lb. protochloride of tin. If blue shades are wanted, use instead of the protochloride of tin oxalic acid or alum, and for red and bronze shades stannate of soda. For very deep shades pass from the sumac into nitrate of iron. Wash.

For the dyeing add $1\frac{1}{2}$ to 2 gallons of the dissolved colour to sufficient cold water; stir well, enter the cotton, work for fifteen to twenty minutes in the cold, then apply the heat, and raise slowly to a boil. Wash and dry.

Or (60 lbs. yarn)—

Dissolve 1 lb. tannin, and work well in the clear solution; pass into a water to which 3 lbs. double muriate of tin have been added, rinse, and dye with 1 lb. induline, previously dissolved in 2 gallons methylated spirit, and the clear solution added to a cold water. Dye as in the foregoing receipt.

China Blue (50 lbs. yarn).

Dissolve 4 lbs. alum and $6\frac{1}{2}$ ozs. "China Blue" (Berlin

Anilin Aktien Gesellschaft). Enter yarn at 120° F., turn briskly, raise to 150° F., and work to shade. Or prepare with tannin, and then dye as above, without the alum.

Another Blue (50 lbs. yarn).

Dissolve 3 lbs. alum, $1\frac{1}{2}$ lbs. carbonate of soda, 4 ozs. tartaric acid, and 6 ozs. "cotton blue $4\frac{1}{2}$ " (Baden Aniline). Enter yarn at 120° F., raise heat to 140° F., turning continually to shade.

Bright Brown (22 lbs.).

Dissolve in water—

Catechu	8 $\frac{3}{4}$ ozs.
Blue-stone	1 $\frac{1}{2}$ oz.

Enter, steep for an hour, wring, and make up a fresh boiling water with bichromate of potash $8\frac{3}{4}$ oz. Enter for a quarter of an hour, give several turns, and wring. Make up another water with the decoction of

Sumac	6 $\frac{1}{2}$ lbs.
Curd Soap	10 $\frac{1}{4}$ ozs.
And work into it oil	3 $\frac{1}{2}$ ozs.

Stir up, enter, give seven turns, add $3\frac{1}{2}$ ozs. salt of tin, stir up; re-enter, give seven more turns, wring, and prepare a fresh cold water containing a little Bismarck brown, and dye to shade.

For a darker shade use—

Catechu	4 lbs. 6 ozs.
Blue-stone	7 ozs.

and for the chrome bath $17\frac{1}{2}$ ozs. bichromate of potash.

Mode Brown—a yellowish Cinnamon (11 lbs.).

Enter in a water at 122° Fahr. with 2 lbs. 3 ozs. pale catechu. Six turns, and enter in a weak bath of chromate of potash at 88° F. Re-enter in the first beck to which $\frac{3}{4}$ oz. tin crystals have been added.

Solid Brown (22 lbs.).

Boil in water 2 lbs. 3 ozs. catechu ; let settle and dissolve in the clear solution 7 ozs. blue-stone. Enter at 212° F., work for an hour ; wring, and make up a fresh boiling water with $5\frac{1}{4}$ ozs. bichromate of potash. Work in this for half an hour, and rinse.

Boil in water $3\frac{3}{4}$ lbs. sumac, work for fifteen minutes at 190° F., lift, and add $5\frac{1}{4}$ ozs. tin crystals. Enter again, work for a quarter, and wring. Pass in a fresh water, with—

Garnet magenta	$3\frac{1}{2}$ ozs.
Alum	$3\frac{1}{2}$ ozs.

Work for half an hour at 100° F.

Brown on Cotton Wool (110 lbs.).

Dissolve $32\frac{3}{4}$ lbs. catechu in boiling water ; add $8\frac{3}{4}$ lbs. blue-stone ; boil the cotton for two hours in the solution ; lift, drain, and enter in a fresh boiling water with $8\frac{3}{4}$ lbs. chromate of potash ; work for an hour, drain in the centrifugal, rinse, drain again in the centrifugal, and dry.

Brown on Sewing Cotton (20 lbs.).

Give four or five turns in catechu at 3° Tw., and raise

in chrome or clear lime-water. Wash in clean water, and run into fustic liquor. Sadden with three pails fustic liquor, two pails redwood liquor, and one pail logwood liquor; four turns. Now add one gallon alum liquor at 8° Tw., give four or five turns; wring out, and dry.

Light Brown on Sewing Cotton (20 lbs.).

Run through catechu liquor at 3° Tw., raise with chrome in a fresh water; wash, and run into fustic liquor, to which is added 1 quart solution of blue-stone. If not rich enough top with Bismarck brown to shade.

Hair Brown, Light Blonde (60 lbs.).

Boil 6 lbs. cutch and 6 ozs. blue-stone till dissolved. Add to a hot water, give three turns; put down all night; one turn in the same liquor in the morning, and wring out. Dissolve 1 lb. alum in a hot water; enter, give three turns, and lift. Boil $\frac{1}{2}$ lb. turmeric and $\frac{1}{2}$ lb. logwood extract together; add this to the alum-water; give four turns, wash in a cold water and dry.

Hair Brown, Dark Blonde (60 lbs.).

Prepare with cutch and blue-stone as above. Then dissolve 6 ozs. chrome; add to a hot water; four turns with yarns. Let off. Add to a warm water 1 lb. alum; three turns, and wring. Boil 2 lbs. fustic extract and 2 ozs. logwood extract together, and add to a warm water. Four turns, lift, and add two quarts of dissolved copperas; three turns, wash in cold water, and dry.

Light Red Brown (60 lbs.).

Boil 12 lbs. cutch with 12 ozs. blue-stone till dissolved. Add this to a hot water, give three turns; put down all night; give one turn in morning, and wring out. Dissolve 12 ozs. chrome; add this to a hot water; give the yarns four turns, and run off. Dissolve 1 lb. alum in a hot water; give three turns more, and wring. Boil $1\frac{1}{2}$ lbs. extract of fustic and 4 ozs. extract of logwood together; add this to a hot water, four turns, and lift. Add 1 quart of copperas water; give three turns more; wash in cold water, and dry.

Dark Medium Brown (60 lbs.).

Boil 12 lbs. cutch and $1\frac{1}{2}$ lb. blue-stone till dissolved; add this to a hot water; give three turns with yarns, and put down all night. Give one turn in morning, and wring up. Dissolve 1 lb. chrome, add it to a hot water, give three turns, and let off. Dissolve 1 lb. alum, add it to a hot water, give three turns, and wring out. Boil 2 lbs. fustic extract and $\frac{1}{2}$ lb. logwood extract together; add these to a hot water; four turns, and lift. Add 3 quarts of copperas water; three turns more; wash in cold water, and dry.

Dark Brown (60 lbs.).

Boil 18 lbs. cutch and 2 lbs. of blue-stone, and proceed as above. Use 2 lbs. chrome, 2 lbs. alum, 2 lbs. fustic extract, 2 lbs. logwood extract, and 1 gallon copperas water.

Very Dark Brown (60 lbs.).

Boil 18 lbs. of sumac; put down in this all night; take through 2 gallons black liquor in a cold water; wash off

in two waters, and wring up. Boil 3 lbs. cutch and 1 lb. blue-stone; add the solution to a hot water, give four turns, and lift. Dissolve $1\frac{1}{2}$ lb. chrome; add to a hot water, give four turns. Go through the chrome and cutch three times each, and finally sadden with 2 quarts copperas water. Wash in cold water, and dry.

Cinnamon Brown (10 lbs.), Cloth, or Yarn.

Take through catechu liquor at 4° Tw., or, in case of piece goods, run three or four times backwards and forwards in a jigger. The temperature of the bath is about 180° F. Then pass into a solution of chrome (bichromate of potash) at $1\frac{1}{2}$ ° Tw., and wash.

Make up a tub (or, in case of pieces, a jigger) with about 30 gallons fustic liquor, 6 gallons redwood liquor, and $\frac{1}{4}$ lb. annatto, previously dissolved in the usual manner. Give three turns, lift, add 4 quarts alum liquor at 8° Tw.; give three or four turns more, lift, and finish.

Very Deep Bismarck on Velveteen Cords, &c. (one piece, 40 to 45 lbs.).

Work first in catechu liquor at 4° Tw. and 180° F. Pass into chrome at 2° Tw. and 150° F. Wash off, and run through 60 gallons of fustic liquor; lift, drain, and dry; singe, and repeat the whole process. Make up a water at 170° to 180° F., with 8 to 10 ozs. Blackley brown (Messrs. Levinstein and Co.); finish without washing. The fustic liquor is made at the rate of 1 lb. fustic to 3 gallons of water.

Madder Brown on Cotton Cloth (600 yards).

Pad the cloth in 6 galls. red liquor and 1 gall. black

liquor, with an equal quantity of water. Dry in the machine or padding stove; let age for twenty-four hours; run through boiling chalk water, and bring into a water at 170° F., with 40 lbs. bark and 20 lbs. madder, and work for an hour; wash, and finish. For darker shades, the cloth must be first prepared with sumac or myrabolans.

Medium Brown on Cords or Beavers (70 to 80 lbs).

Run through cutch liquor, at 2½° Tw. and 180° F., four times in a jigger; chrome in warm water, and run into two fustic liquors of 20 pails each; add to the second fustic liquor 1 quart annatto liquor. Then work well in a tub, with 5 pails sumac liquor, 3 pails redwood liquor, 2 pails logwood liquor, and 10 pails fustic liquor. Then run into a warm water, with 4 quarts of copperas liquor at 8° Tw.; work well, in two waters, and run again into two fustic liquors, to the second of which 1 quart annatto liquor is added, and top with Bismarck brown to shade.

Dark Brown on Cords or Beavers.

Run through cutch at 3° Tw., giving four turns with a jigger at 180° F. Give four turns in a warm solution of bichromate of potash at 1½° Tw.; wash in two warm waters; run into two fustic liquors, each time about 20 pails, adding to the second fustic liquor 1 quart annatto liquor. Work in a tub with 5 pails fustic liquor, 3 pails logwood liquor, and 10 pails fustic liquor; pass into a warm water, with a little sumac and 1 gallon copperas water, at 8° Tw. Wash in warm water, and run into two fustic liquors of 20 pails each, with 1 quart annatto liquor in the second. Work again with 4 pails of sumac liquor, 2 pails logwood liquor, 6 pails redwood liquor, and 8 pails fustic liquor; then pass into a warm water with 1 gallon copperas water

at 8° Tw. Work well, wash in warm water, and run into two fustic liquors as before, and top with Bismarck brown to shade.

Light Browns on Cords.

Run through a jigger with cutch at 2° Tw. at 160° F. ; take through a warm chrome water ; wash in two waters, and run into two fustic liquors 20 pails each, to the second of which 1 pint annatto is added. Then work in 2 pails sumac, 2 pails redwood liquor, 1 pail logwood liquor, and 15 pails fustic liquor. Run into a warm water with 2 quarts copperas liquor at 8° Tw. Wash in warm water, and run into 20 pails fustic liquor, with 1 pint annatto liquor, and top with Bismarck brown as required.

Common Brown (100 lbs.).

Boil 20 lbs. catechu in water, dissolve in the liquid 10 lbs. alum, let settle, enter yarn in hot liquid ; and, after working well, take out, and enter into a fresh boiling water, with 4 lbs. yellow chromate of potash. Rinse and soften with oil and soap.

Dark Nacaral (10 lbs.).

Boil 2 lbs. catechu in water ; dissolve in the solution 5 lbs. bluestone, and work the yarn at a boil. Leave them in the liquid over-night ; lift the next morning, and take through a boiling water, with $\frac{1}{2}$ lb. chromate of potash. Take out and steep for half an hour in a solution of tin at 3° Tw. Lift and top at a hand heat with the decoction of 2 or 3 lbs. logwood. Work in this for an hour ; lift, add $1\frac{1}{2}$ ozs. tin crystals, re-enter, work, wring, and dry.

Fast and Bright Brown (10 lbs.).

Boil in water 2 lbs. best Pegu catch. Dissolve in the liquid 3 ozs. blue-stone, and make up with water to 14 gallons. Let settle, heat the clear to a boil, enter the yarn, and let steep for two hours. Lift, enter in a fresh boiling water with $\frac{1}{2}$ lb. bichrome. Give six turns, lift, and rinse in cold water.

If a finer shade is desired it may be entered in a water at 100° F., with $\frac{1}{2}$ lb. alum, 1 oz. tin crystals, and a little magenta.

Noisette, six shades (11 lbs.).

No. 1. Make up 87 pints water at 68° F., with $\frac{1}{4}$ lb. sumac and $1\frac{1}{4}$ oz. prepared catechu. Enter the yarn, steep for an hour, lift, and add $2\frac{1}{4}$ ozs. nitrate of iron; six turns, and wring well out. Make up a fresh water at 86° F., with $\frac{1}{2}$ oz. chromate of potash; six turns, and take through warm water.

No. 2. Make up the first beck with $8\frac{3}{4}$ ozs. of sumac and $2\frac{1}{4}$ ozs. prepared catechu. Steep for an hour, lift, and add $3\frac{1}{2}$ ozs. nitrate of iron; re-enter, six turns, and enter in a water at 86° F., with 1 oz. chromate of potash.

No. 3. The first water is at 86° F., and contains the decoction of 13 ozs. sumac, 4 ozs. logwood, and $3\frac{1}{2}$ ozs. prepared catechu. Steep for an hour. Add $3\frac{1}{2}$ ozs. nitrate of iron, give ten turns and take through a fresh beck of $1\frac{1}{4}$ oz. chromate of potash.

No. 4. The first water is made up with 17 ozs. sumac, $8\frac{3}{4}$ ozs. logwood, and $4\frac{1}{2}$ ozs. prepared catechu. Steep for an hour. Add $4\frac{1}{2}$ ozs. nitrate of iron, and give ten turns, and pass through a fresh beck of $2\frac{1}{4}$ ozs. chromate of potash at 86° F.

No. 5. The first water is made up with 26 ozs. sumac, 17 ozs. logwood, and 7 ozs. prepared catechu. Steep for an hour, add $6\frac{1}{4}$ ozs. nitrate of iron, and give ten turns. Take through a beck of $3\frac{1}{2}$ ozs. chromate of potash.

No. 6. 2 lbs. 3 ozs. sumac, and the same weight of logwood for the first beck. Use $9\frac{1}{2}$ ozs. nitrate of iron, and take through $6\frac{1}{4}$ ozs. chromate of potash

Light Buff (60 lbs.).

Bleach; add to a cold water 3 pints nitrate of iron. Work yarns five times, and wring. Add clear lime-water to a fresh cold water, give five turns and wring, re-enter in the iron-liquor, five turns, wash off and dry.

Another Light Buff (60 lbs.).

Bleach; work yarn five times in dilute clear lime-water, and wring; boil 2 ozs. Bismarck brown (Brooke, Simpson, and Co.), and add to a cold water. Work five turns, wash in cold water, and dry.

Dark Buff (60 lbs.).

Boil 6 lbs. turmeric with 3 lbs. alum in 6 galls. water, and add this to a hot water. Work yarns five times and lift, add 3 pints nitrate of iron, 3 turns more, wash in cold water, and dry.

Another Buff (11 lbs.).

Boil 1 oz. to $1\frac{3}{8}$ ozs. annatto in the solution of $2\frac{1}{2}$ ozs.

soda ash, and work the yarn for an hour at a boil. Lift, and top in a fresh water with magenta and a little alum.

Chocolate (11 lbs.).

Work for half an hour at 167° F. in a water of 8 $\frac{3}{4}$ ozs. prepared catechu, lift, and pass five to seven times through a fresh water at the same heat made up with 1 $\frac{1}{4}$ oz. chromate of potash. Lift, and top in a fresh water with about $\frac{1}{10}$ oz. magenta and 15 grains extract of indigo.

Claret (11 lbs.)

Make up a water with 17 ozs. prepared catechu, and work the yarns for an hour. Wring and steep for half an hour in a hot water with 6 $\frac{1}{4}$ ozs. chromate of potash, take through cold water and work for half an hour in a water at 190° F. with 3 $\frac{1}{2}$ lbs. sumac. Dye in a cold water with 1 $\frac{1}{4}$ oz. magenta, lift, and add to the water 8 $\frac{3}{4}$ ozs. alum and the decoction of 2 $\frac{1}{4}$ lbs. logwood. Enter again, work, lift, and add from $\frac{1}{3}$ to 1 $\frac{3}{4}$ oz. chromate of potash, re-enter and work.

Cream-colour (11 lbs.).

Boil out $\frac{3}{4}$ oz. prepared catechu in water, and dissolve 2 lbs. 3 ozs. curd soap in the clear liquid. Enter the cotton at 190° F., and work for an hour.

Dove on Velvets.

Run through 60 gallons of water, to which 10 gallons logwood liquor and 5 gallons sumac have been added. Lift, add 3 quarts copperas liquor at 8° Tw., enter, run through again, wash, and finish.

Light Drab (60 lbs.).

Boil 6 ozs. redwood extract till dissolved. Add the liquor to a warm water, work five turns, lift, and add $1\frac{1}{2}$ pint black liquor. Three turns more, wash and dry.

Medium Drab (60 lbs.).

Increase the peachwood extract to 1 lb., and work as above.

Dark Drab (60 lbs.).

Boil 6 lbs. cutch until dissolved (without any blue-stone), add to a hot water, five turns, run off, and wring. Dissolve $1\frac{1}{2}$ lb. peachwood extract, add to a warm water, five turns, lift, and add 1 quart black liquor, three more turns, wash and dry. For a yellower shade, boil a little extract of fustic along with the peachwood; for a redder shade add a little alum along with the peachwood, and for a browner tone top with a little Bismarck brown.

Drab on Velvets.

Run four or five times through a bath made up of 60 gallons fustic liquor, 20 gallons sumac liquor, and 1 pint of dissolved annatto. Lift, add 4 quarts of copperas liquor at 8° Tw. Run four or five times through, wash, and finish.

Light Drab on Cords.

Work with 1 pail sumac, 2 pails fustic, 4 quarts logwood, and $1\frac{1}{2}$ pints annatto, filling the tub up with warm water. Run into a warm water with 3 pints copperas liquor at 8° Tw., and wash off in warm water.

Drab (100 lbs. yarn).

Dissolve 8 lbs. alum and $\frac{1}{4}$ lb. nigrosine (F. Beyer and Co., of Elberfeld). Enter at 120° F., and turn constantly to shade whilst raising the heat.

Fawn on Velvets.

Make up a catechu bath at 2° Tw. and 180° F., run through this, pass into chrome bath at 1° Tw., wash and sadden with 60 gallons fustic, and 30 galls. sumac. Lift, add 4 quarts copperas at 8° Tw., run through again, wash, and finish.

Prussiate Green (22 lbs.).

Dissolve 2 lbs. 3 ozs. alum in lukewarm water, and give two turns. Dissolve in fresh water 17½ ozs. solid extract of bark. Work for an hour and wring three times. Prepare two cold waters, the first with 7 ozs. nitrate of iron slightly soured with sulphuric acid, and the second with 3½ ozs. yellow prussiate.

Give five turns in each, lift, and wring. Before taking out of the second add 2 ozs. muriatic acid, rinse, wring, and dry.

For heavy greens take—

Extract of bark . . .	2 lbs. 3 ozs.
Nitrate of iron . . .	12 ozs.
Yellow prussiate . . .	7 ozs.

Grass Green (55 lbs.).

Steep the cotton, previously boiled, for a night in water with 8½ ozs. alum. Next morning rinse, wring, and enter

in a water at 140° F., containing 13 lbs. 2 ozs. bark. Work for forty-five minutes, wring, and dye to shade in a water containing 4 lbs. 6 ozs. soda crystals, and Nicholson blue (BBB) $8\frac{1}{4}$ ozs. The colour, of course dissolved, should be added in two portions to prevent unevenness. Work for half an hour, lift, and add to the beck the solution of $3\frac{1}{4}$ lbs. alum. Six more turns, rinse, wring, and dry.

Cœruleine Green.

Mordant with chrome alum, or take the yarn alternately through chromate of potash and bisulphite of soda.

For the dye-beck stir up the cœruleine with twice its weight bisulphite of soda at $71\frac{1}{2}$, and let the mixture stand for some hours before adding it to the dye-beck.

Methyl Green (22 lbs.).

Dissolve $17\frac{1}{4}$ ozs. tannin in water, enter the cotton at 167° F., and steep for fifteen minutes, giving several turns. Wring, and add to a fresh cold water the solution of $3\frac{1}{2}$ ozs. methyl green, enter yarns, give twelve turns, wring, and dry.

Or (for 11 lbs.).

Dissolve 3,100 grains tannin in a boiling water, enter the bleached cotton over-night in the hot solution, wring out and dye in cold water with a solution of the colour according to shade. Wring, and dry in the dark without washing.

For lighter shades bleach well and work in warm soap-water to remove chlorine. Enter in a boiling lye of curd soap, and wash out in cold water. Make up a cold water with 3 parts of colour for every 100 of cotton, give five or six turns, and steep over-night. Dry the next morning. If the shade is not full enough, take again through the

tannin bath, and dye again to shade. For yellower tones dye a yellow ground with fustic and alum, and top cold with the green.

Emerald Green on Cotton Velvets.

Give a yellow ground with fustic liquor. Work well, lift, and add 4 quarts solution of alum at 10° Tw. Work well, and wash in two clear waters. Repeat the same operation and fold the pieces up. When dry, blue the pieces in the vat to the shade required.

Light Blueish Green (11 lbs.).

Extract 17 ozs. turmeric at a boil, and add to a water. Steep for two hours, lift, add $1\frac{3}{4}$ to $2\frac{1}{2}$ ozs. sulphuric acid, re-enter five times, take out, wash well, and dye a prussian blue in the following:—

a. 3 ozs. tin crystals, $8\frac{3}{4}$ ozs. nitrate of iron.

b. $4\frac{1}{2}$ ozs. yellow prussiate, $2\frac{1}{2}$ ozs. sulphuric acid. If the blue is required darker repeat the operation.

Night Green for Cotton Velvets, Velveteens, &c.

Boil 3 lbs. nut-galls in 4 gallons water, let settle, draw off the clear and dilute it with 20 galls. water. Bring this liquor into a jigger at about 150° F., enter the piece and run it through six times, add a pint of double muriate of tin, and run through again. Wash and run through a bath prepared with 20 gallons of water, to which 4 gallons fustic liquor have been added. Run through six times, add to the fustic 4 quarts alum liquor at 8° Tw. Run through several times more, lift and drain in a centrifugal.

Make up a jigger with 20 galls. water, and $\frac{1}{2}$ lb. of night-green paste, previously dissolved; when all the colour has been taken up, take up and finish. (Methyl green, Helvetia green, or Malachite green, according to shade, will now be substituted for the night-green paste.)

Blue Green (on Cords, Beavers, and Beaverteens).

Boil the goods in soda ash for an hour, and leave folded up in clear water to drain. Give a good ground in the vat, sour, wash well in two or three waters, and sadden in 50 gallons logwood liquor, and 30 gallons fustic liquor. Add 2 quarts copperas water, and 2 quarts blue-stone liquor, and run through again. Wash in two waters and run the pieces into 70 gallons fustic liquor. Drain, add 3 quarts blue-stone water at 8° Tw., run through and wash. Give five turns in each operation. This is a blueish olive.

Chrome Green (on cloth or yarn).

Give a vat blue ground, run through, sour, and wash in clean water. Run through sugar of lead at 6° Tw., then through caustic soda at 2°—3° Tw., wash off, and run through bichromate of potash at 2° Tw.

Cloth requires three or four turns, yarn five or six turns.

Green on Yarn (100 lbs.).

Dissolve

Nitrate of iron	10 lbs.
Tin crystals	1 lb.

Work through the cold solution, give five turns, and wring. Dissolve in another water 6 lbs. yellow prussiate, give the yarn six turns in the cold solution, wring, and pass back to

the nitrate of iron, and thence return to the prussiate bath, to which 2 lbs. alum have been added, give three dips in each, and rinse.

Boil 40 lbs. bark for an hour, strain the decoction into a tub, add 1 lb. sugar of lead, well dissolved, and when all is mixed, enter the yarn at 180° F., and turn it for half an hour, wring, and take it through another water, containing—

Alum	.	.	.	.	.	2 lbs.
Indigo paste	.	.	.	.	.	2 „

Rinse and dry.

Cheap Green.

Prepare yarns over night in a decoction of sumac. Boil 25 lbs. fustic for one hour, in a bag. Add to the liquid 2½ lbs. verdigris dissolved in acetic acid and hot water. Cool the dye and enter the yarns, turn well, and heat up to a boil. Keep the yarn half an hour in the bath, let it cool, and enter it in another water containing the decoction of 10 lbs. logwood, heat to a boil, and keep it there for half an hour; lift and rinse.

By using blue-stone instead of verdigris an olive-green shade is produced.

Grey (31 lbs.).

Extract 30 ozs. fustic at a boil. Enter the yarns at a hand heat, and steep for fifteen minutes. Sadden with 30 ozs. copperas. Wash well, and wring. Enter in a cold water with 60 ozs. alum, and dye up to shade with a little induline. (Williams Brothers and Ekin.)

Mode Grey on Cotton Wool (22 lbs.).

Enter in water with the extract of 11 lbs. logwood, work

for half an hour in the cold, lift, and add copperas, 4 lbs. 6 ozs. Re-enter and work to shade; lift, rinse, and dry.

Slate Grey on Cotton Wool (22 lbs.).

Make a decoction of

Sumac	2 lbs. 3 ozs.
Catechu	17 $\frac{1}{2}$ ozs.

Enter the cotton at 122° F., and let steep for an hour, turning from time to time. Lift, and add to the water 8 $\frac{3}{4}$ ozs. nitrate of iron, re-enter, and work till the colour is level. Lift, wring, and add to a fresh water 6 $\frac{3}{4}$ ozs. bi-chromate of potash. Heat to 140° F., enter the cotton, give seven turns, let steep till cold, and dry.

Silver Grey (55 lbs.).

Six turns in the decoction of 13 ozs. gall-nuts, wring, and pass into a cold water with 3 lbs. 4 $\frac{1}{2}$ ozs. copperas, and 1 lb. 10 ozs. blue-stone. Seven turns, rinse, and dry.

Mode Grey (55 lbs.).

Boil in a water 3 $\frac{1}{4}$ lbs. catechu and 17 ozs. dry extract of logwood, and dissolve 8 $\frac{3}{4}$ ozs. each copperas and blue-stone. Enter yarns at 122° F., and work for half an hour.

Another Mode Grey (11 lbs.).

Make up 11 gallons of water at 77° F., with 4 $\frac{1}{2}$ ozs. sumac, and 14 $\frac{1}{2}$ ozs. prepared catechu; enter, steep for an hour, lift, and add 2 $\frac{1}{2}$ ozs., by weight, of nitrate of iron, at

71° Tw. Six turns, and wring off. Make up a fresh water at 100° F., with $\frac{2}{3}$ oz. chromate of potash; enter yarn, six turns, and take through clear water.

Darker shades are made by increasing the proportions of the wares.

Light Grey on Cotton Pieces (60 lbs.).

Boil $1\frac{1}{2}$ lb. solid extract of logwood, and $\frac{1}{2}$ lb. solid extract of bark in water. Run the pieces six to eight times through, squeeze, and run through a fresh beck of water with 5 lbs. copperas. Rinse, and finish with the dressing directed for pansy.

Medium Grey (60 lbs.).

Increase the extract of logwood to $2\frac{1}{2}$ lbs., and the bark to $\frac{3}{4}$ lb., and use 10 lbs. copperas.

Dark Grey (60 lbs.).

Four pounds extract of logwood, and $1\frac{1}{2}$ lb. extract of bark. Add to the finishing mixture logwood and copperas enough to colour it slightly. If a yellow tone is required add more bark liquor, and for a reddish shade take a little sapan-liquor.

Stone Grey (25 lbs.).

Boil 25 lbs. sumac, and 1 lb. fustic. Enter, give five turns, wring, and enter in a cold water with 1 lb. copperas, and $\frac{3}{4}$ lb. blue-stone. Five turns, rinse, and dry.

Fast Grey (22 lbs.).

Mix $1\frac{1}{4}$ pint olive oil and the solution of 2 lbs. 3 ozs. soda crystals. Work the cotton in this mixture at a boil for thirty minutes, wring, and dry. Then powder 44 lbs. coal very fine, add $15\frac{1}{4}$ lbs. soda crystals and $17\frac{1}{2}$ pints boiling water. Let the mixture steep for some hours, and then boil for half an hour in 227 pints of water; strain and work in the hot liquid for a quarter of an hour, and wring well. Repeat this process five times, wringing each time. Wash in lukewarm water, then in cold water, wring and dry. Pass into weak size, to which a little emulsive oil has been added, wring, and dry.

This grey resists soap, acids, and chloride of lime, but it is not beautiful.

Mode Grey (11 lbs.).

Work for two hours with the decoction of 35 ozs. sumac, and $4\frac{1}{2}$ ozs. fustic. Lift and dye in a fresh water, with $4\frac{1}{2}$ ozs. copperas. Top in fresh water with gentiana, blue, or methyl violet.

Maroon on Cotton (75 lbs. yarn).

Steep over-night in decoction of 18 lbs. sumac, wring, and enter cold in a bath of oxy-muriate of antimony, 2° Tw., work for four hours, wash, wring, and enter dye-bath of 4 pails redwood liquor, and 9 ozs. "garnet" (Farb-werke, Hoechst am Main) at 120° F., and raise to 160° F., turning constantly.

Deep Olive (11 lbs.).

Boil in sufficient water 14 ozs. sumac, work for an hour

in the clear, and make up a fresh water with 26 ozs. copperas.

Work for fifteen minutes, wring and prepare a beck of red liquor at $1\frac{1}{2}^{\circ}$ Tw., raise to 140° F., give ten turns, lift, wring, and enter in a fresh water, at 140° F., containing $5\frac{1}{2}$ lbs. fustic. Work for an hour, and wring. Bark may be used in place of fustic.

Light Olive (10 lbs.).

Boil 1 lb. bark in water. Boil $\frac{1}{2}$ lb. turmeric in another vessel, and mix the decoctions. Dissolve in the liquid 5 ozs. alum and $1\frac{1}{2}$ oz. extract of indigo, or more, as the shade may require. Steep the yarn in this liquid at 88° F., and top to shade with a decoction of peachwood.

Light Olive (11 lbs.).

Boil $3\frac{1}{4}$ lbs. fustic in water, make up a bath with the extract, dissolve in it $17\frac{1}{2}$ ozs. alum, enter yarn, and steep for an hour. Lift, and dissolve in the bath $1\frac{1}{4}$ oz. extract indigo. Re-enter, and work for fifteen minutes.

Medium Olive (11 lbs.).

Extract $8\frac{1}{2}$ ozs. sumac in boiling water, enter the yarn in the clear liquid, let steep, and make up a fresh water with $8\frac{1}{2}$ ozs. copperas. Enter the yarn (previously wrung out), work for fifteen minutes, wring, and enter in a fresh beck of red liquor at $1\frac{1}{2}^{\circ}$ Tw. Give twelve turns at 148° F., wring, make up a fresh water with the decoction of 2 lbs. 11 ozs. bark, and work half an hour.

Aniline Orange (60 lbs.).

Bleach, boil 3 lbs. tannic acid, and add this to a warm water. Work yarns five turns, and wring. Spirit with 3 quarts nitro-muriate of tin, and wash in cold water with a little soap in the last water. Dissolve 12 ozs. aniline orange, add this to a warm water, wash, and dry.

Annatto Orange (60 lbs.).

Boil 6 lbs. best annatto in 2 lbs. soap and 2 lbs. common soda till dissolved, and add this to a boiling water. Work yarn five turns, wash in cold water, and dry. This colour may be topped with various wares.

Full Orange (60 lbs.).

Dissolve 12 lbs. sugar of lead in 12 gallons of clear lime-water, and add the solution to a cold water. Work yarn five turns, and wring. Dissolve 4 lbs. bichromate of potash, and add to a cold water. Work five turns and wring, and repeat twice in the old liquor, wringing each time. Heat lime-water to a boil, and work yarn five turns quickly. Wash off in warm water with a little soap and dry.

Orange on Cotton Velvets, &c.

Pour 10 gallons boiling water on 4 lbs. of turmeric, but do not boil; stir up well, let settle, and run the clear into a jigger; make up with water to 20 gallons, and add $\frac{1}{2}$ lb. annatto, which has been boiled with $\frac{1}{4}$ lb. of pearl-ash. Run the piece six times through, and add 4 quarts solution of alum at 8° Tw., and $\frac{1}{4}$ pint oil of vitriol. Run

through several times more, wash, dry, and it is ready for finishing.

Cheap Orange (50 lbs.).

Dissolve 10 lbs. sugar of lead, boil for half an hour with 4 lbs. litharge, let settle, and enter the yarns in the solution of basic acetate of lead thus obtained. Give two turns, lift, wring, and take through weak lime-water, and then into a warm water containing the solution of 6 lbs. bichromate of potash. After fifteen minutes lift and take through boiling lime-water very quickly. Rinse and dry.

Fine Orange (11 lbs.).

Boil $21\frac{3}{4}$ ozs. annatto in the decoction of 11 ozs. soda crystals, filter, and work in the hot clear liquid for half an hour. Lift, and pass through a fresh water at 100° F. with 17 ozs. alum, to which a little magenta may be added if a redder tone is required.

Or :—

Steep the well-bleached yarns over night, $6\frac{1}{4}$ ozs. tannin. Take out and dye at 144° F. with aniline orange.

Alizarine Red for Yarns (220 lbs.).

Prepare in neutral alizarine oil. Dry the yarns in the stove, and steam for $\frac{3}{4}$ hour at $1\frac{1}{2}$ atmosphere pressure. Mordant in red liquor at 14° Tw., and wash well.

Dye for $1\frac{1}{2}$ hour at 158° F. with the following mixture:—

Alizarine, at 10 per cent.	.	.	44 lbs.
Acetate of lime, at 33° Tw.	.	.	22 lbs.
Sulpholeic acid	.	.	11 lbs.

Steam for an hour, and soap as may be needed, with or without the addition of carbonate of soda. A little tin crystals may be added to the red liquor to raise the colour.

The selection of alizarines depends on the tone of colour aimed at. "Alizarine for reds" used alone, gives the most vivid red. If a bluer tone is desired, a little "alizarine for violet" is added.

Or (22 lbs.)—

Boil the yarn in soda-lye at 4° Tw., wash, and dry in the air.

Pass into a beck containing 24 ozs. of alizarine oil in 26 pints of water at 122° F.; wring, and dry in heat.

Mordant with red liquor 10½ pints, at 8½° Tw.; dry in heat, and age for twenty-four hours.

Dung with 11 lbs. cow-dung and 2 lbs. 3 oz. chalk in 44 pints of water at 150° F. Wash thoroughly and wring.

Make up the dye-beck as follows:—

Hot water		350 pints.
Acetic acid		7 ozs.
Alizarine oil		3 lbs. 7 ozs.
Water, into which has been pressed the juice of 6½ lbs. bran, after being boiled for an hour		17 pints.
Alizarine, for reds		27½ ozs.

Enter cold, work for an hour, raise very slowly to a boil in an hour and a quarter, boil for ¾ hour; lift, drain overnight, wash, wring, and dry.

Pass into a beck containing—

Alizarine oil		24 ozs.
Water at 95° F.		26 pints.

Wring and steam for an hour at the pressure of one atmosphere.

Brighten in a closed boiler with—

Soap	8 $\frac{1}{4}$ lbs.
Soda-crystals	2 lb. 3 oz.
Tin crystals	7 ozs.

Wash and dry in the air.

Or—

Mordant in cold red liquor at 6 $\frac{1}{4}$ ° Tw. Let steep for two hours, turning often. Lift, wring, and air for twenty-four hours. Enter in a fresh beck containing $\frac{1}{4}$ per cent. of chalk, and dye at 212° F. with a solution of alizarine in a wooden vessel.

Aniline Scarlet (60 lbs.).

Bleach; boil 3 lbs. tannic acid, and steep the yarn overnight in the solution. Mordant with permuriate of tin (red cotton spirits). Wash off in two cold waters and wring up. Dissolve 6 ozs. aniline scarlet, and add the solution to a warm water. Work the yarn for an hour, giving ten turns; wash in cold water, and stove dry.

Another Aniline Scarlet (60 lbs.).

Bleach and mordant as in the last receipt. Boil 3 lbs. turmeric and 3 ozs. aniline ponceau, and add the solution to a hot water. Work yarns ten turns, wash in cold water, and stove.

Common Scarlet (60 lbs.).

Bleach; boil 6 lbs. sumac, and add this to a hot water. Work the yarns five turns, and wring; mordant in tin, as in the preceding receipts. Wash in two cold waters, and wring up. Boil 18 lbs. peachwood and the same weight of fustic ground, and add the decoction to a hot water.

Work the yarns ten turns, and raise with 1 lb. alum. Wash in cold water, and stove.

For lighter shades the sumac may be omitted, and turmeric used in place of fustic.

Saffranine Scarlet (60 lbs.).

Bleach; boil 2 lbs. annatto with 1 lb. soap and 1 lb. soda until well dissolved, and add to a boiling water. Work ten turns, wash in two cold waters, and wring up. Mordant in red liquor, wash off in two waters, and wring. Add to a beck of warm water 2 lbs. of saffranine. Work yarns in this for one hour, giving ten turns. Wash in cold water, and stove.

Saffranine Scarlet (60 lbs.).

Soak yarn for twelve hours in hot water, wring and soak for an hour in the warm decoction of 20 lbs. sumac. Lift and pass through nitro-muriate of tin at $2\frac{1}{2}^{\circ}$ Tw. Rinse three times, and wring. Extract 2 lbs. turmeric in a little water, add a boil; add the decoction to a cold water, and add further $19\frac{3}{4}$ ozs. saffranine, previously dissolved in $3\frac{1}{2}$ pints of boiling water, and filtered. Enter the yarn, and gradually raise the heat to 131° F., turning well for half an hour.

Or—

Take the bleached goods through stannate of soda at $2\frac{1}{2}^{\circ}$ Tw., and leave for an hour; take through vitriol sours at $\frac{1}{2}^{\circ}$ Tw., and wash. Dye with aniline scarlet. Pass through a water with tartar emetic, drain in the centrifugal, and top in a fresh water with saffranine. Afterwards pad in a 10 per cent. solution of alizarine oil, dry, and steam.

Another Saffranine Scarlet (11 lbs.).

Boil 2 lbs. 3 oz. annatto in water with 13 ozs. soda-ash. Make up with the decoction a boiling water. Enter the yarns, previously bleached, and work for half an hour. Rinse and enter in a fresh water at 144° F. along with 1½ oz. curd soap. Give six turns; lift, and dye to shade in a fresh water at the same heat with a clear solution of saffranine. Lift, and dry.

Peachwood Scarlet (55 lbs.).

Boil together for twenty minutes 11 lbs. sumac and 5½ lbs. turmeric. Steep the yarn over-night in the clear liquid; lift, and give five turns in tin solution at 2½° Tw. Give five turns in a water with 13 lbs. peachwood, and let steep for two hours. Lift, and let steep three or four hours in a fresh water with 26 lbs. peachwood and 5 lbs. 7½ ozs. alum.

The tin solution is prepared as follows:—

Muriatic acid	.	.	.	.	.	3 parts.
Nitric acid	.	.	.	.	.	1 part.

To every 2 lbs. 3 ozs. of this mixed acid take 4¼ ozs. tin crystals.

The second peachwood beck may be saved and used for the first peachwood steep of the next lot.

Safflower Scarlet (60 lbs.)

Bleach; boil till quite dissolved 3 lbs. concentrated annatto with 1 lb. soap, 1 lb. soda crystals, and add this to a beck of boiling water. Work yarns one hour, ten turns. Wash in two cold waters and wring.

Add to a water one bottle carthamine (extract of safflower), work yarns four turns and lift; add 3 pints acetic acid; re-enter, work till all the colour is taken up. Wash off in three cold waters, to the last of which 1 lb. cream of tartar is added. Wring, and dry cold.

Another Scarlet (100 lbs.).

Steep over-night in the decoction of 20 lbs. sumac. Work for fifteen to twenty-five minutes in a beck of oxy-muriate of antimony at 2° Tw., wash well, and dye to shade with

Ponceau 2 B (Berlin Aktien Gesellschaft) . 1 $\frac{1}{4}$ lb.
Enter at 70° F., and raise heat not above 90° F.

Another Scarlet (50 lbs.).

Steep over-night in the decoction of 18 lbs. sumac. Wring, and enter in oxy-muriate of antimony at 2° Tw. Give three or four turns, and let steep for half to three-quarters of an hour. Wash, and dye up with—

Saffranine	.	.	.	.	.	10 ozs.
Phosphine	.	.	.	.	.	4 ozs.

(Berlin Aktien Gesellschaft.)

Enter at 60°, and turn rapidly, raising the temperature to (but not above) 110° F.

Ponceau 3 R. Berlin Aktien Gesellschaft.

Soap, and dry; mordant for an hour in red liquor at 17° Tw., free from lead. Wring and dye in a fresh water to which the dissolved colour is added. Heat slowly to a boil, and let the cotton cool in the bath.

The red liquor is prepared as follows:—

1. Eight parts sulphate of alumina, 14 water, 7 soda crystals.
2. Ten parts sugar of lead and 7 water.

Each of these liquids is boiled separately, and when cooled down to a hand-heat they are mixed; the mixture is stirred, let settle, and filtered.

This process may be used for fixing any of the ponceaux and the Bordeaux of the same company upon cotton.

Saffranine Pink (60 lbs.).

Bleach and mordant in red liquor. Wash well from this in two or three cold waters, and wring. Add to a warm water 1 lb. saffranine paste; work five turns, wash off in cold water, and stove.

Safflower Pink (60 lbs.).

Bleach and add 3 gills of extract of safflower (carthamine) to a water. Work yarns for six hours, giving them a turn every half hour, and keep them in the liquid till all the colouring matter is taken up; add towards the close a little acetic acid to raise the shade. Wash off in three waters, adding to the last 1 lb. cream of tartar, and dry cold.

Aniline Pink (50 lbs.).

The yarns, well bleached, are entered at 110° F. in a water with—

Sulphate of soda	5 lbs.
Pink (Baden Anilin Fabrik)	4 ozs.

Turn well; lift, heat to 140° F., and finish. The dye-ware should not all be added at once.

Erythrosine Pink (50 lbs.).

Add to a lukewarm water—

Sulphate of soda crystals	5 lbs.
Erythrosine B.S. (Meister, Lucius, and Brun- ing)	5 ozs.

Enter yarns at 120° F., and turn to shade, raising the heat gradually to 140° F. It is recommended to add the colour—of course dissolved—in two equal portions.

Phloxine Pink (50 lbs.).

Dissolve common salt in the water till it marks 5° Tw. Add the solution of 6 ozs. Phloxine Extra B.B. (P. Monnet and Co., Geneva). Enter yarns at 70° F., and give five turns whilst the temperature is raised to 100° F.; wring and dry, without washing.

Safflower Rose (60 lbs.).

Bleach; work as for safflower pink, but double the quantity of carthamine, and give a little more time.

Magenta (50 lbs.).

Add to a water at 144° F.—

Tin crystals	5 $\frac{7}{8}$ ozs.
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And the solution of the same weight of magenta, which is added in two portions, giving six turns after each.

Resorcine Colours (Eosine and Phloxine Reds and Roses).

Soap hot with curd soap for an hour, and wring without rinsing. $8\frac{1}{4}$ ozs. alum are dissolved in $1\frac{1}{4}$ pint water, and made up to 17 pints, $1\frac{1}{2}$ ozs. soda crystals are added, the solution is let settle, and the clear liquid is drawn off for use. The yarn is boiled in this for ten to twelve hours, and is then entered in 17 pints of water and $6\frac{1}{4}$ to $10\frac{1}{4}$ ozs. of alizarine oil, which before being added to the beck should be well shaken up with $1\frac{1}{4}$ pint water. In this mordant the yarn is steeped for an hour, wrung and dried.

For dyeing take 17 pints pure water, 7 fluid ozs. red liquor at $8\frac{1}{4}^{\circ}$ Tw., and colour as required. Enter the yarn at 122° F., and raise gradually to 190° F.; steep till the bath is exhausted, wring without washing, and dry.

The red liquor is made by dissolving $4\frac{1}{2}$ ozs. alum in $8\frac{1}{4}$ fluid ozs. boiling water, and adding the solution of $3\frac{1}{2}$ ozs. sugar of lead in the same quantity of water. Mix the solutions, let settle, strain, and set the clear at $8\frac{1}{4}^{\circ}$ Tw. The water used must be free from lime.

Coralline Red (11 lbs.).

Make up a hot water with 2 lbs. 3 ozs. turmeric. Work yarns for one hour, rinse in cold water, and prepare another water at 86° F. with—

Soap	.	.	.	.	.	.	$1\frac{1}{4}$ ozs.
Olive oil	.	.	.	.	.	.	$3\frac{1}{2}$ „

Work in this for fifteen minutes and wring. Dye in a cold water containing a trace of tartaric acid and a solution of soluble red coralline.

The quantity of tartaric acid is regulated by the greater or less yellowness of the shade required; or—

Boil in water white starch $4\frac{1}{4}$ ozs., and add the same

weight of glue. Enter the yarn at 86° F., work for fifteen minutes, rinse, and dye in a water at the same heat to which more or less solution of coralline has been added, according to shade.

Or—

Boil 35 ozs. sumac or 2,790 grains of tannin in water, and steep the cotton all night in the hot clear liquid. Wring out next morning, and enter in a fresh water at 122° F. with 17½ ozs. good glue; wring out and dye to shade with coralline in cold water; wring again, and without washing dry in a room whose atmosphere is impregnated with ammonia.

Aurine is dyed in the same manner as coralline.

Magenta on Cotton-wool (110 lbs.).

Add to a boiling water 5 lbs. 7ozs. tannin. When perfectly dissolved enter the cotton and boil for two hours; reduce heat and steep for another hour. Dissolve 2 lbs. 3 ozs. soap, dilute the tannin beek sufficiently, and work the cotton well. Lift, drain in the centrifugal, and dye in a fresh water with 27—31 ozs. magenta.

Rose Bengale (P. Monnet and Co.).

Work the cotton for an hour in water containing 5 per cent. of alizarine oil, dry, steep for two hours in cold red liquor at 2½° Tw., and enter in the dye-beek, which for every 35 ozs. cotton, contains ½ oz. colour and ¾ oz. of the above red liquor. The process takes one hour at from 112° to 140° F.

The red liquor is made by dissolving 3¼ ozs. alum in 17¼ ozs. water, and adding 1½ oz. acetate of lime, previously dissolved in another 17¼ ozs. water. It is let settle, decanted, or filtered if needful, and set at 2½° Tw.

Eosine.

Work the yarn in a soap-beck, dry, and transfer to a beck of sugar of lead. Rinse and dye at a hand-heat in an eosine beck. The addition of a little acetic acid gives a yellower tone.

Cochineal Red (10 lbs.).

Boil 1 lb. best annatto with $\frac{3}{4}$ lb. potash; strain the solution, and work the yarn in it at a moderate heat. Wring, and take the yarn twice through a lukewarm water; wring and pass it into the solution of 2 ozs. glue, to which $1\frac{1}{2}$ oz. nitric acid has been added. Work for a quarter of an hour, wring, and enter in a tin mordant at 10° — 11° Tw. Work for half an hour, wring, and dye with $1\frac{1}{4}$ lb. cochineal.

Wood Red.

Steep over-night in 12 lbs. sumac; next morning spirit it in nitro-muriate of tin at 12° Tw. (cold). Wash off well, and dye with 10 lbs. barwood and 30 lbs. brazil wood at a boil, turning for an hour.

Barwood Red (10 lbs.).

Boil out 2 lbs. sumac, and add the decoction to a water in which the goods are steeped for six hours. Wring out, and work in so-called barwood spirit at 2° Tw. Wring, and enter in a water at 200° F. with 10 lbs. rasped barwood, raise to a boil, which is kept up till the shade is obtained.

Mock Scarlet (10 lbs.).

Prepare in 30 gallons hot sumac liquor, with 1 lb. turmeric. Give seven turns, lift, and pass into a cold water with 1 pint of crimson spirit (nitro-muriate of tin, a solution of the perchloride); seven turns, wash, and enter in 30 galls. hot redwood liquor. Lift, wash, and if not full enough, take again through the spirit and the redwood liquor.

Crimson Liquor for Padding Velvets.

Dissolve $2\frac{1}{4}$ lbs. sal-ammoniac in 6 quarts hot water; then add to it 6 quarts cold water and 9 lbs. common salt, stir well until all is dissolved, and strain through a double cloth into a 12 gallon stoneware bowl. Add to the solution 2 quarts gum-tragacanth water, $4\frac{1}{2}$ gallons sapan liquor at 8° Tw., and $1\frac{1}{4}$ pint nitrate of copper at 78° Tw.; stir well for three minutes, add $7\frac{1}{2}$ pints oxymuriate of tin, stir, fill up the bowl with cold water, and strain for use. Pad once through at night and hang up to drain, run through the same liquor next morning and dry. When dry, turn over, expose to the air to cool, and after about two hours wash in three waters and dry.

If a more scarlet colour is required, add 1 pint black liquor to the above before padding.

Cochineal Scarlet (100 lbs.).

Boil 10 lbs. annatto with 6 lbs. soda-ash; strain into a tub and enter the yarns in the liquid very hot; leave there for half an hour; lift and rinse in very warm water.

Dissolve glue	.	.	.	.	10 lbs.
Nitric acid	.	.	.	.	$7\frac{1}{4}$ „

Pass the yarn into this solution lukewarm for a quarter of an hour; lift, wring, and pass into a tin mordant at 11° Tw. Keep it under the surface of the liquid for half an hour, lift, wring, and dye up in a water containing:—

Cochineal	12 lbs.
Tin composition	3 „

Steep for a few hours. Top with magenta if needed.

Cheap Scarlet (100 lbs.).

Prepare in a decoction of 25 lbs. sumac, and let steep over-night.

Next morning wring out well and take through a “nitrate of tin” at 5½° Tw., give five turns and wring.

Take through a cold solution of:—

Alum	12 lbs.
Fustic liquor	6 pails.
Chalk	1 lb.

(The chalk serving to reduce the alum to the basic condition). Give five turns, wring, and take through the decoction of 30 lbs. redwood. Steep a few hours, and dry.

The nitrate of tin above mentioned is thus prepared:—

Nitric acid at 62° Tw.	5 lbs.
Muriatic acid at 33° Tw.	2½ lbs.
Water	2 lbs.
Feathered tin	¾ lb.

Add the tin very gradually.

Cheapest Scarlet (100 lbs.).

Pass for two hours into a decoction of 20 lbs. turmeric, lift, rinse, and pass into a water containing 8 lbs. sugar of

lead and 5 lbs. alum, for fifteen minutes. Wring and dye up in 3 or 4 ozs. magenta, according to shade.

This scarlet will be blackened by sulphurous fumes and will fade in the sun.

Azo Reds (110 lbs.).

Dissolve in water $6\frac{1}{2}$ lbs. card soap, and 2 lbs. 3 ozs. white glue in water. Enter the yarn and work for an hour, wring out, and pass into a cold water with perchloride of tin at $6\frac{1}{4}^{\circ}$ Tw. Work for an hour, lift, and enter in a water of red liquor at $11\frac{1}{4}^{\circ}$ Tw. Work for two hours, lift and pass into a cold water containing more or less of the colouring matter as according to shade. Turn constantly, and raise the heat slowly to 190° F., let remain for some time in the hot flot, wring out, and dry.

Or, for a cheaper and inferior colour—

Dissolve sulphate of alumina, 10 per cent. of the weight of the yarn, and convert it into basic sulphate by the following process. Add gradually solution of soda, with constant stirring, till the precipitate formed does not entirely disappear, but leaves a few floating flakes. Then make a small quantity of a fresh solution of sulphate of alumina and add it very carefully, stirring continually, till these last flakes are dissolved, set the liquid at 14° Tw. Enter yarns for two hours, turning occasionally, lift and dye up in a fresh water with colour=10 per cent. of the weight of the cotton.

Roe colour (11 lbs.).

Work for an hour at 167° F. in a water of 17 ozs. catechu. Lift and enter in a fresh water at the same heat with $\frac{3}{4}$ oz. chromate of potash. Lift and top in a fresh beck with about $\frac{3}{4}$ oz. alum, and 30 to 45 grains of fustic.

Bright Salmon.

Boil in a water 11 lb. sumac. Dissolve in the decoction $8\frac{1}{2}$ ozs. soda crystals, and stir in $13\frac{3}{4}$ ozs. olive oil. Enter yarns, steep for an hour at 140°F. , lift, add to the water $10\frac{1}{2}$ ozs. tin crystals, re-enter, turn for half an hour, wring and dye to shade in a fresh cold water with $8\frac{3}{4}$ ozs. aniline orange, wring, rinse, and dry.

Light Slate (60 lbs.).

Boil 24 ozs. logwood extract till dissolved, and add this to a warm water. Give yarns five turns, lift, and add $1\frac{1}{2}$ pint black liquor. Three more turns, wash in cold water, and dry.

Medium Slate (60 lbs.).

As above, but take 3 lbs. logwood extract, and 3 pints black liquor.

Dark Slate (60 lbs.).

Boil 6 lbs. sumac, add the liquor to a hot water. Work five turns, and wring up. Boil 3 lbs. logwood extract till dissolved, and add this to a warm water. Five turns, lift, and add 3 pints black liquor. Give three turns more, wash in cold water, and dry.

These colours may be modulated by using along with the above ingredients small quantities of fustic and alum.

Slate on Velvets.

Run four or five times through 60 gallons of logwood liquor, and 30 gallons of sumac. Add 4 quarts copperas liquor, run several times, wash, and finish.

Slate on Cotton Wool (100 lbs.).

Extract of logwood	4 lbs.
Sumac	20 lbs.

Boil for fifteen minutes, enter the cotton, turn well, and let boil for an hour. Lift, drain well, and enter in a cold water in which have been dissolved :—

Copperas	8 lbs.
Blue-stone	4 lbs.

Slate (10 lbs.).

Boil for an hour with $\frac{1}{2}$ lb. soda. Make a decoction of 6 ozs. sumac, enter yarns and steep for six hours, wring, and pass into a cold solution of 3 ozs. copperas. Give six turns, rinse and wring, and pass back to the sumac bath for an hour.

Make a decoction of $\frac{1}{3}$ oz. extract of logwood. Enter in this for two hours; wring, and pass into another water containing the solution of 25 grains bichromate of potash, and give five turns.

Alizarine Violet (220 lbs.).

Mordant with alizarine oil, and proceed as for a Turkey-red. Mordant again with 270. lbs. sumac, or 200. lbs. good pale myrobalans. Dry and pass into 175 quarts of water, with copperas 76 lbs., blue-stone $15\frac{1}{4}$ lbs. When the whole is dissolved, work the cotton in the liquid at a boil, wring, wash, and wring again. Dye to shade with "alizarine for violets," i.e., such as contains no anthrapurpurine. When cold, wash in plenty of water and raise with soap only, very neutral, at a boil. If a very blue tone is required raise with soap dissolved in a weak lye of soda-crystals, say $1\frac{1}{2}^{\circ}$ Tw.

Methyl Violet (50 lbs.).

Boil yarn for two hours and wring. Make up a cold water with 5 ozs. nitric acid and $1\frac{1}{4}$ lb. starch, previously stirred up in cold water. Give a few turns, wring, and dye to shade in a lukewarm water with 1 lb. methyl violet.

Or, work well in a soap-lye, wring, and take through a solution of chloride of calcium or nitrate of lime. Rinse and pass into a very weak tannin bath, and dye in clear solution of methyl violet about 7 ozs. of dry to 60 lbs. yarn.

Methyl Violet (22 lbs.).

Dissolve $3\frac{1}{2}$ ozs. tannin, and 1 oz. curd soap in hot water, add $\frac{1}{2}$ oz. colza oil, and stir till an emulsion is formed. Work in this at 167° F. for fifteen minutes, lift, and wring. Make up another water at the same heat with $10\frac{1}{4}$ ozs. alum, and the filtered solution of 2 ozs. methyl violet. Enter and dye to shade.

Reddish Violet (11 lbs.).

Mix 4 lbs. 6 ozs. starch in cold water, pour in hot water, stirring constantly so as to form a smooth even paste, and make up to 105 pints at 100° F. Six turns and then steep for fifteen minutes, turning occasionally. Lift and add to 105 pints of water at 100° F., $1\frac{3}{4}$ oz. alum, and 30 grains of soluble aniline violet. Six turns.

Gentiana Violet (11 lbs.).

Boil 35 ozs. sumac or 2,790 grains of tannin in water, and steep the yarn over-night in the clear solution. Wring up

and dye in a water at 165° F., containing 9 ozs. gum arabic, adding the dissolved colour as required. Wring, and dry.

Or—

Make up a water at 122° F. with 80 grains tannin for each 35 ozs. cotton, and turn the yarns for four or five hours.

Wring and enter in the dye-beck at 110° F., to which 775 grains of acetic acid are added per 11 lbs. cotton.

Pansy for Piece Goods (10 pieces = 60 lbs.).

Boil 15 lbs. sumac and run the goods eight to ten times through the clear hot liquor. Lift, drain, and run six times through tin solution at 2½ Tw. The tin solution is prepared by dissolving 8 ozs. tin in 3 lbs. muriatic and 1 lb. nitric acid. Squeeze and run ten to twelve times through a fresh cold water prepared with 50 lbs. logwood. Lift and dissolve in the same bath 2 lbs. alum, and 1 lb. tin crystals, run six times through, and wash. Finish with the following mixture: 45 lbs. farina, 3 lbs. wax, and 6 lbs. cocoa-nut oil boiled to a stiff paste with the addition of a few pounds of logwood and a little alum. The pieces are calendered out of this mixture and pressed.

Spirit Purple (10 lbs. cloth or yarn).

Prepare with stannate of soda at 10° Tw., sour in vitriol at 2° Tw., and wash twice in clean water. Make up a machine (tub for yarns) with 30 gallons logwood liquor, run three or four times backwards and forwards, add 4 quarts alum, ½ pint double muriate of tin, and run three or four times through, and wash off in clean water.

Make up another machine with 30 gallons logwood liquor and 10 galls. redwood liquor, run three or four times. Add ½ pint purple spirit and 4 quarts alum. Run through several times, wash, and finish.

Fine Yellow (60 lbs.).

Bleach, mordant in red liquor, boil 3 lbs. picric acid in 3 gallons water, add this to a warm water, work five turns, and dry.

Light Yellow (60 lbs.).

Bleach, boil 3 lbs. turmeric in 3 gallons water with 3 lbs. alum, add this to a hot water. Work five times, wash, and dry.

Straw Yellow (60 lbs.).

Mordant with either red liquor or nitromuriate of tin. Boil $1\frac{1}{2}$ lb. extract of fustic in 3 gallons water, and add to a warm water. Work yarn five turns, wash in cold water, and dry.

Fast Yellow (60 lbs.).

Bleach, dissolve 6 lbs. brown sugar of lead in 6 gallons of boiling water, and add this to a cold water. Work five turns, and wring. Dissolve 2 lbs. bichromate of potash, and add it to another cold water. Work yarn five turns, wash in two cold waters, and dry.

Dark Rust Yellow. Yarns and Cotton Wool (110 lbs.).

Work up in a hot water 11 lbs. yellow rosin soap with 4 lbs. 6 ozs. annatto and 2 lbs. 3 ozs. young fustic. Steep for half an hour at a boil.

Old Gold on Cotton (100 lbs. yarn).

Boil $\frac{3}{4}$ lb. flavine and dissolve 2 lbs. alum. Enter yarn

at 160° F., give eight turns, hang out, add to the dye 1 oz. Bismarck brown and $\frac{1}{2}$ lb. redwood. Re-enter, turn to shade, wring, and dry.

LINEN DYEING.

The properties of linen, as far as its behaviour with mordants and dyewares is concerned, do not essentially differ from those of cotton. It is, however, less able to resist strong acids and chemicals. The proportion of linen goods dyed and printed is but small in comparison with those sold in the white state.

Coarse linen yarns are very largely used in the warps of certain classes of carpeting.

Black (50 lbs. yarn).

Boil 10 pails of decoction of logwood with 2 lbs. blue-stone and 2 lbs. soda-ash. When dissolved, cool down to 180° F., enter the yarn dry, and work for twenty minutes. Lift, rinse, and dry.

Black Linen Sewing Thread.

Wet out in boiling water, and enter in a water at 212° F., made up of 17 ozs. solid extract of logwood, and $3\frac{1}{2}$ ozs. solid extract of bark. Work for an hour, lift, and hang out in the air for twelve hours. Re-enter in the extract beck, which should be at 88° F., give eight turns, and lift. Work for a quarter of an hour in a fresh cold water, with $6\frac{1}{4}$ ozs. blue-stone, lift, and dissolve 17 ozs. soda-ash in the old extract bath. Enter yarns and give ten turns. Lift, return to the blue-stone water, seven turns. Take out, return to the extract beck, and give seven more turns.

Next dissolve in the blue-stone water 7 ozs. copperas. Enter yarns, give ten turns, and return to the extract bath for seven turns. Make up a fresh boiling water with $8\frac{3}{4}$ ozs. curd soap, and give seven turns. Oil or glycerine may be added to the soap-beck to insure softness.

Black (40 lbs.).

Steep for an hour in a solution of 4 lbs. extract of logwood. Squeeze well and pass eight times through a cold water with $7\frac{1}{2}$ ozs. bichromate and 12 ozs. blue-stone. Take out and squeeze, and dissolve in the old extract-beck 1 lb. soda-ash. Enter, heat to 167° F., take out, squeeze again, dissolve in the beck 1 lb. copperas. Work for half an hour, and rinse. To hinder the goods from smearing take through a water containing a little gum.

Fast Black (50 lbs. yarn).

Steep over-night in the hot decoction of 15 lbs. sumac. In the morning lift and take through a warm water made up with 5 lbs. copperas, 1 lb. blue-stone, and 2 lbs. whiting.

Work in a cold, weak lime-water, rinse, and return to the sumac cistern, to which must be previously added six pails decoction of logwood, and 1 lb. of starch paste.

Blues.

For linen the cold copperas vat, or the improved hydro-sulphite vat, may be used exactly as for cotton.

Topped Blues (11 lbs.). Three Methods.

First Method—

Give a light blue in the vat, sour, rinse, and add to a

cold water 1 oz. tin crystals, and 3 lbs. 6 ozs. nitrate of iron. Work for two hours, lift; make up a fresh cold water with $2\frac{3}{4}$ to $3\frac{1}{4}$ lbs. logwood, and 17 ozs. alum. Dye cold for a quarter of an hour and rinse. If the colour is not to rub off, take through a lukewarm water with $4\frac{1}{2}$ ozs. glue, and dry.

Second Method—

Vat as before, and make up a water with “indigo substitute,” a mixture of induline and extract of logwood. Enter, work at 144° F. for thirty minutes, and sadden in a fresh water with $1\frac{1}{2}$ oz. chromate of potash, and $\frac{3}{4}$ oz. blue-stone.

Third Method—

Vat as before, and work for an hour in a water of 11 lbs. logwood, and 17 ozs. alum. Make up a fresh cold water with 2 lbs. 3 ozs. copperas. Give ten turns, and according to shade give two or three dips in both becks. If not deep enough, add a little nitrate of iron to the logwood. Rinse and take through weak glue water.

Blue without Indigo (on 55 lbs. yarn).

Put the yarn for two or three hours in water with $8\frac{3}{4}$ ozs. copperas, and dry without rinsing. Steep for three hours in a water with 26 ozs. alum; wash, wring, and dye in a decoction of logwood, to which the solution of $1\frac{3}{4}$ oz. alum, and of the same weight of sugar of lead has been added. Give three turns, and the dyeing is complete.

Light Blue (pieces 72 yards, 29 inches wide).

Boil with 35 ozs. soda-ash, rinse, and give a light blue in the vat. Sour with $3\frac{1}{4}$ lbs. sulphuric acid, and rinse.

Mix 108 pints water with 35 ozs. wheat starch, and the clear solution of $\frac{3}{4}$ oz. gentiana violet B, and $8\frac{1}{4}$ ozs. alum. Take through this at 122° F., and calender.

If the colour need not be quite fast, give a paler shade in the vat, and prepare the following finish. Boil 11 lbs. logwood in water, and dissolve in the clear decoction 17 ozs. alum. Boil in the liquor $3\frac{1}{4}$ lbs. starch, let cool, and stir in 17 ozs. sulphate of zinc, and $\frac{3}{4}$ oz. tin crystals. Make up 105 pints, work in it for half an hour, dry, and calender. Let the pieces run evenly through the mixture.

Aniline Blue (50 lbs.).

Dissolve 4 ozs. aniline blue in 1 pint hot methylated spirit, and stir the solution well into a water at 140° F. Stir in also 2 lbs. acetic acid, and the solution of 3 lbs. sulphate of soda crystals.

Enter, raise gradually to about 210° F., turning constantly ; lift, rinse, and dry.

Prussiate Blue (50 lbs.).

Add to a water, slightly warm, 3 lbs. nitrate of iron, and 2 lbs. tin crystals. Enter, and give five turns, pass into a fresh water made up with the solution of 2 lbs. yellow prussiate, and 1 lb. oil of vitriol. Lift, drain, and re-enter in the iron bath. If not dark enough, take again through the prussiate. Lift, rinse, and dry.

Brown (50 lbs.).

Dye first a flavine yellow, as directed below. Mordant with the "aniline spirit" (see chapter on Mordants, p. 70). Enter in a water made up with the decoction of 10 lbs. redwood and 10 lbs. logwood, turn for twenty minutes. Rinse, and dry.

If a maroon shade is required, use more redwood and less logwood.

Another Brown (50 lbs.).

Add to a water at 140° F., 5 lbs. alum, 5 lbs. "aniline spirit," and 10 pails of logwood liquor. Work for twenty minutes, rinse, and dry.

Catechu Fast Brown (50 lbs.).

Steep yarns over-night in the decoction of 10 lbs. cutch or gambir. Lift, work in a hot solution of bichromate of potash, lift, rinse, and dry.

Madder Brown (50 lbs.).

Add to a water 5 lbs. boiled madder and 5 lbs. alum. Enter yarn at 150° F. Five turns, add 2 lbs. double muriate, work fifteen minutes, lift, rinse, and dry.

Light Green (10 lbs.).

Digest for six hours with $6\frac{1}{2}$ lbs. sumac. Wring out and enter for half an hour in the following mordant:—Alum, 500 grains; sugar of lead, 250 grains. Wring out and dye with 100 grains iodine green.

Fast Green (110 lbs.).

Boil for four hours in the solution of 4 lbs. 6 ozs. silicate of soda, blue slightly in the cold vat, take through vitriol sours, wash, take through weak lime-water, and wash again. Steep over-night in a water at 167° F. with $3\frac{1}{4}$ lbs. blue vitriol. Wash the next morning, and take

through a fresh water at 167° F. with 5¼ lbs. fustic, saddening with logwood if needed.

Green (50 lbs.).

Add to a water 5 lbs. alum, 2 lbs. double muriate, 2 ozs. tin crystals, and ¼ lb. flavine. Boil together for ten minutes, cool, enter yarn, work very quickly and then more slowly for twenty minutes. Lift and rinse.

Make up a cold water with a solution of 1 lb. extract of indigo and 6 lbs. alum.

Enter yarns, turn quickly at first, and let steep for some hours, turning occasionally. Lift and dry without rinsing.

Greenish Grey (22 lbs.).

Dissolve 17 ozs. soda-ash in a water, and boil for an hour. Wash, and take through a fresh water with 17 ozs. sulphuric acid, and wash again. Stir up 2 lbs. 3 ozs. of the best chloride of lime to a uniform paste and allow to settle. Soak the goods in the clear liquid for six hours, turning occasionally. Lift, and take through a fresh water to which 35 ozs. muriatic acid have been added. Rinse well. Boil out 8¼ ozs. sumac, and 35 ozs. bark in sufficient water. Enter the goods for an hour in the clear liquid at 122° F., press, and pass into a fresh water with 8¼ ozs. copperas. Work here for fifteen minutes, and take through water. Make up a water at 122° F. with 35 ozs. alum; enter the goods, and add by degrees very small quantities solution of bark and extract of indigo till the shade is hit. Rinse and dry.

Iron Grey (11 lbs.).

Work for an hour in a boiling water with 35 ozs. sumac.

Wring, and work for another hour in a fresh water with the same weight of copperas.

Lilac (50 lbs.).

Add to a decoction of logwood at a hand-heat 4 lbs. alum, and 2 lbs. double muriate. Work for twenty minutes, lift, rinse, and dry.

Blueish Mode (11 lbs.).

Mordant at 167° F. with 35 ozs. sumac, and work in a cold water with 35 ozs. copperas. Rinse, and dye up in a fresh water with alum, extract of indigo, and magenta as required.

Reddish Mode (11 lbs.).

Boil out 7 ozs. prepared catechu in water, work the yarn in the solution at 144° F. for half an hour; lift, and work in a water at 180° F. for half an hour, with 3½ ozs. chromate of potash. Rinse, and top in a fresh beck with alum, extract of indigo, and magenta.

Greenish Mode (11 lbs.).

Work for an hour in a water at 167° F. with 35 ozs. sumac, and 7 ozs. solid extract of fustic. Lift, and work for half an hour in a cold water, with 35 ozs. copperas. Make up a fresh water at 167° F. with 3½ ozs. solid extract of fustic, 8¾ ozs. alum, adding extract of indigo as required, and a very little magenta. Top in this beck.

Aniline Orange (on 11 lbs. linen yarn).

Dye as for yellow and top in a fresh water with $\frac{1}{4}$ oz. saffranine, or rather less.

Chrome Orange (11 lbs.).

Boil up $3\frac{1}{4}$ lbs. sugar of lead in water with an equal weight of litharge till the sediment is white. Let settle, and steep the yarn for an hour in the clear hot liquid. Lift, and take through a cold water with 17 ozs. lime. Rinse slightly and work in a cold water with 17 ozs. chromate of potash, and the same weight of sulphuric acid for a quarter of an hour. Redden for three minutes in a boiling water with $8\frac{1}{4}$ ozs. lime. If a redder shade is needed top in a fresh cold water with $\frac{1}{2}$ oz. magenta.

Madder Orange (50 lbs.).

Add to a hot water 2 lbs. flavine, 10 lbs. alum, 6 lbs. double muriate, $\frac{1}{4}$ lb. tin crystals, and 5 lbs. madder. Boil for ten minutes, cool to 170° F., enter yarns, turn very rapidly at first and then more slowly for about a quarter of an hour.

Lift, rinse, and dry.

Annatto Orange (50 lbs.).

Boil 1 lb. annatto in 4 lbs. soda-ash, and add the decoction to a water at 160°. Enter yarn, work to shade, rinse, and dry.

This is a bright, but not very fast, orange.

*Reds.**Magenta (100 lbs.).*

Dissolve 3 ozs. magenta, and add the solution to a water at 150° F. Stir well, enter, and work for twenty minutes. Lift, and dry without rinsing.

Fast Sanders Red (100 lbs.).

Ground slightly with annatto; mordant by steeping over night in bichloride (oxy-muriate) of tin at 11 $\frac{1}{4}$ ° Tw. Rinse, wring, and enter in a beck made up with 5 lbs. sanders, and work at a boil for twenty minutes. Take through vitriol sours at $\frac{1}{2}$ ° Tw., wring, and rinse.

Crimson (50 lbs.).

Steep in the decoction of 10 lbs. sumac. Work well in a water to which 3 lbs. of "aniline spirit" have been added. Enter in a water at 140° F., to which has been added the decoction of 15 lbs. redwood, working for twenty minutes. Lift, rinse, and dry.

Red (11 lbs.).

Boil for five hours with $\frac{1}{2}$ lb. soda-ash and 2 lb. 3 ozs. lime, rinse and pass into a water containing 8 $\frac{3}{4}$ ozs. muriatic acid. Rinse again and prepare a bleach by stirring up in cold water 8 $\frac{3}{4}$ ozs. chloride of lime. The yarn is steeped six to seven hours in the clear liquid. If the yarn appears white, rinse in cold water, take through muriatic sours at $\frac{1}{2}$ ° Tw., rinse, and work in boiling water containing 17 $\frac{1}{4}$ ozs. tannin. Wring and dry at 167° F. in a fresh water containing 1 $\frac{1}{4}$ oz. yellowish saffranine.

Rose (on 11 lbs. linen yarn).

Work for half an hour at a boil with 7 ozs. tannin and $3\frac{1}{2}$ ozs. curd soap. Lift, and add to the beck the solution of $3\frac{1}{2}$ ozs. tin crystals, and dye at 112° F. with the solution of $\frac{1}{2}$ to $\frac{3}{4}$ oz. aniline red according to shade.

Another Red (50 lbs.).

Boil together 5 lbs. sumac, 5 lbs. alum, 2 ozs. tin crystals, and 1 lb. flavine. Cool the decoction down to 180° F., enter yarns, work for a quarter of an hour, and lift. Take it without rinsing through a cold water, to which 3 lbs. "aniline spirit" has been added. Each lot of yarn is worked in this mordant from about one and a-half minute, and a little more of the spirit is added for each lot. Drain, and make up a water at 125° F. with the decoction of 15 lbs. redwood. Turn quickly at first, and afterwards more slowly for twenty minutes. It is an improvement to add to the colour-bath 2 lbs. whiting, in order to neutralize the acid.

Lift, rinse well, and dry.

Golden Yellow (on 11 lbs. linen yarn).

Steep for three hours in a boiling water with 17 ozs. tannin, wring out and dye in a fresh cold water with $3\frac{1}{2}$ to $4\frac{1}{4}$ ozs. aniline orange, or phosphine.

Yellow (100 lbs.).

Boil together for fifteen minutes 2 lbs. flavine, 10 lbs. alum, 8 lbs. double muriate, and $\frac{1}{4}$ lb. tin crystals. Cool to

170° F., enter yarn, and work with the usual precautions to shade.

Lift, rinse, and dry

JUTE DYEING.

Jute differs markedly in its properties from cotton and linen. It is readily disintegrated by acids, and alkalies, caustic or even carbonated, are apt to turn it brown.

It contains, however, a certain proportion of tannin, which enables it to lay hold of certain dyes, especially the aniline colours, more readily than cotton.

Very high temperatures, and especially prolonged boiling, are avoided whenever possible in the treatment of this fibre.

Black (54 lbs.).

Dissolve $5\frac{1}{2}$ lbs. solid extract of logwood and 17 ozs. extract of bark in water. Steep the jute for a quarter of an hour in the boiling beck, and enter in a fresh cold beck of 13 ozs. red chromate and $8\frac{1}{2}$ ozs. blue-stone. Give seven turns, take out, and re-enter in the logwood-beck in which 21 ozs. soda-ash have been dissolved in the meantime. Seven turns, lift, and dissolve 17 ozs. copperas in the beck, re-enter, five turns, and rinse.

Cheap Black (110 lbs.).

Take 5 lbs. 7 ozs. extract of logwood, 2 lbs. 3 ozs. lime, and 4 lbs. 6 ozs. copperas, and dissolve each separately. Give the yarns three turns at a boil in the solution of the extract, drain, but do not wring: take through the lime-water and immediately after through the copperas, giving three turns in each.

Superior Black (110 lbs.).

Take 7 lbs. 6 ozs. extract and proceed otherwise as above. When drained from the copperas return to the extract.

Blue (100 lbs. yarn).

Dissolve 2 lbs. alum.

„ $\frac{1}{2}$ lb. tin crystals.

„ 10 ozs. serge blue.

Enter yarn, and boil for twenty minutes.

Gend'armes Blue (100 lbs.).

Dissolve 2 lbs. alum.

„ $\frac{1}{2}$ lb. tin crystals.

„ 8 ozs. serge blue.

„ 3 ozs. aniline green.

Enter yarn, and boil for twenty minutes.

Blue (220 lbs.).

Dissolve in separate vessels, alum, 11 lbs. ; soda crystals, 7 lbs. 10 ozs. ; tartar emetic, 5 lbs. 7. ozs. Pour the solutions all at once together, and let settle.

The clear liquid is used with 22 gallons water at 158° F., and the jute is dyed, adding the colour (previously dissolved in water) by slow degrees till the shade is obtained. The colour is the "Bradford Blue" of the Baden Aniline Co.

Blue (110 lbs. bleached yarn).

To a warm water at 104° F. add—

Alum	17½ ozs.
Soda	3½ ozs.
Tartar emetic	1¼ oz.

Dye to shade in methyl blue, soluble in water (Baden Aniline Co.).

Brown (22 lbs.).

Make a boiling decoction of 3¼ lbs. catechu, dissolve in it 3½ ozs. blue-stone. Work the jute for an hour. Wring and make up a second boiling water with 7 ozs. bichromate of potash, ten turns, rinse, and wring. Raise and top in a fresh water with 75 grains Bismarck brown, and 3½ ozs. sulphate of soda. For redder shades a little magenta or garnet may be added.

Another Brown (11 lbs.).

Mordant at a boil with 2 lbs. 3 ozs. sumac. Give a few turns, lift, and add to the beck 1¼ oz. tin crystals. Give a few more turns, and make up a water with 2 lbs. 3 ozs. logwood, 2½ ozs. magenta, 13¼ ozs. alum. Work for an hour in the cold, lift, and add 2½ ozs. chromate of potash, seven or eight turns, rinse, and dry.

Bismarck Brown (11 lbs.).

Wet out and dye with ½ oz. to 1 oz. vesuvine.

Brown (11 lbs.).

Extract 35 ozs. catechu in boiling water and dissolve

3½ ozs. blue-stone in the clear. Enter the jute in this for two or three hours at a boil. Lift, and dissolve 8¼ ozs. chromate of potash in a boiling water, pass the jute through this, and then through clear water. Top in a fresh water with 80 grains Bismarck brown, 4½ ozs. alum, and 17½ ozs. logwood.

Dove Colour.

Mordant in red liquor at ¼° Tw. and 86° F.

Dye in fresh water at the same heat, with a very little methyl blue and less saffranine.

Gold (22 lbs.).

Enter the bleached yarn for twenty minutes in a lukewarm bath of sugar of lead. Wring, and give ten turns in a new cold water containing 7 ozs. bichromate of potash, and rinse. For deeper shades increase the sugar of lead and the bichromate. For redder tones take the dyed jute through a lukewarm water containing a little garnet, or a very red aniline violet, previously dissolved in boiling water.

Golden Bronze.

Work in weak catechu liquor at 122° F., then pass into bichromate of potash at the same heat, and lastly dye to shade with a mixture of phosphine and vesuvine (Baden Aniline Co.) at 122° F.

Golden Orange (110 lbs.).

Mix 11 lbs. alum and 17½ ozs. tin crystals in sufficient water, run off the clear, and steep the jute in it for half an hour, and dye at a hand-heat in a separate water with

chrysoidine and phosphine RN. (Baden Aniline Company) according to shade.

Add a little tartaric acid towards the end, to raise the colour.

Light Green (11 lbs.).

Mordant for two hours in the solution of 7 ozs. tannin. Make up a fresh water with $1\frac{1}{4}$ oz. malachite green, enter the jute, and work for half an hour. For yellower tones add to the dye-beck picric acid or aniline yellow.

Fast Green (22 lbs.).

Work for half an hour in a hot water containing $27\frac{1}{4}$ ozs. extract of bark and 14 ozs. sulphate of alumina. Wring, and prepare two waters—

a. $15\frac{1}{2}$ ozs. nitrate of iron and $3\frac{1}{2}$ ozs. tin crystals.

b. $3\frac{1}{2}$ ozs. yellow prussiate.

Work for twenty minutes in a; wring, and pass into b. Ten turns, lift, and add 14 ozs. sulphuric acid; ten turns more, lift, wring, rinse, and dry.

Night Green (11 lbs.).

Prepare at a boil for three hours with the clear decoction of $8\frac{1}{4}$ ozs. sumac. Wring, and enter in a beck of $1\frac{1}{4}$ oz. methyl green. If a yellower tone is wanted a little picric acid may be added.

Green (110 lbs.).

Mordant with red liquor at $4\frac{1}{2}^{\circ}$ Tw. and $17\frac{1}{2}$ ozs. tin crystals. Let steep an hour, enter in a strong hot decoc-

tion of fustic, wring out and dye in a fresh water with $17\frac{1}{2}$ ozs. alum and acid green (*vert à l'acide*, of Monnet and Co.) according to shade.

Aniline Green (45 lbs.).

Prepare hot with 5 lbs. sumac for one hour, and then mordant with 4 lbs. alum and $2\frac{1}{2}$ lbs. sugar of lead. Let it lie for a couple of hours, and dye it warm with the aniline green previously dissolved.

Light Green (11 lbs.).

Boil out $8\frac{1}{4}$ ozs. sumac; steep for three hours in the clear boiling liquor. Lift and make up a fresh cold water with methyl green; enter, and work till level. For yellower tones add picric acid.

Mode Green on Jute Yarn (110 lbs.).

Mix 3 parts fustic liquor and 1 part logwood liquor with the necessary quantity of water at 122° F., ten turns, lift, add $\frac{1}{4}$ oz. each copperas and blue-stone; re-enter, turn well, and wash.

Top at 86° F. with vesuvine and a little methyl blue (of the Baden Aniline Co.).

Grey (11 lbs.).

Boil 17 ozs. sumac in water, and steep the jute for an hour in the liquid. Lift, and dissolve the same weight of copperas. Enter the yarns, and dye to shade.

For a blue-grey make up a fresh beck at 77° F. with 17 oz. alum and $\frac{1}{2}$ oz. extract of indigo. Add a very little solution of magenta, enter the jute, and dye to shade.

Mode Grey (11 lbs.).

Boil 17 ozs. prepared catechu, add solution to a water at 100° F., and dissolve therein $1\frac{3}{4}$ oz. blue-stone. Wet out the jute at 100° F., enter, and work for an hour. Lift, and add the solution of $1\frac{3}{4}$ oz. chromate of potash; re-enter, work to shade, rinse, and dry.

Pansy (11 lbs.).

Wet out perfectly at 100° F., lift, and add $\frac{1}{2}$ oz., or a little more of dissolved violet (Hofmann's, or methyl). Enter, five turns, and dry.

REDS.

Red (11 lbs.).

Mordant hot for an hour with $8\frac{3}{4}$ ozs. tannin; lift, wring, and enter in a beck of phosphine or aniline orange, and top with a solution of saffranine at 113° F.

If aniline orange is too dear, yellow coralline may be used.

Crimson (11 lbs.).

Wet out perfectly in water at 100° F., and dye with $\frac{1}{4}$ oz. to $\frac{1}{2}$ oz. magenta.

Wood Red (25 lbs.).

Dye the half-bleached yarn, hot, with $\frac{3}{4}$ lb. annatto which has been boiled with 6 ozs. soda-ash. Steep the yarns for an hour in the solution. Wring, and enter in a cold water with 2 lbs. stannate of soda. Lift, and enter in a luke warm water with 4 to 5 lbs. alum; turn for half

an hour, wring, and dye up with peachwood liquor (12 lbs. of wood).

Wood Crimson (25 lbs.).

Make a decoction of 4 lbs. sumac, add it to a hot water, and steep the yarn over-night; wring, spirit with stannate or nitro-muriate of tin, and dye in peachwood liquor.

Azo Red (110 lbs.).

Dissolve 11 lbs. cake-alum, and add so much solution of soda that the precipitate formed ceases to disappear entirely on stirring the liquid. Then add a little of a fresh solution till the last traces of the precipitate are just dissolved. Set the solution at 14° Tw.; enter the clear goods, and work for two hours, turning occasionally. Lift, and pass into a fresh water containing 1 lb. dye for 10 lbs. yarn.

The same process is applicable to hemp.

Scarlet on Jute Yarn.

Mordant with red liquor at 8 $\frac{1}{4}$ ° Tw. and 122° F.

Dye to shade in a fresh water at the same heat with "écarlate R. R." (of P. Monnet and Co., Geneva).

WOOL DYEING.

Under this head we include not merely wool, but alpaca, goats' hair, and other true animal fibres, and also the treatment of mixed goods, in which the warp is of

cotton, linen, jute, &c., and the web of wool. Wool is dyed both loose or in the unmanufactured state, in yarns, in piece-goods, and in rags or shoddy, and in each of these conditions it requires certain modifications of treatment.

The properties of wool in relation to colouring matters differ very decidedly from those of the vegetable fibres, which circumstance involves a corresponding difference in the dyeing processes used. It has a much stronger attraction or affinity for the majority of colours than have the vegetable fibres, and in many cases mordants are not required. This happens especially with certain of the aniline colours. One and the same colour very generally appears richer, brighter, and fuller if fixed upon wool than upon cotton. This is very decidedly the case with indigo, which upon cotton or linen has a dull, flat appearance, whilst upon wool it is much brighter.

Wool is, with few special exceptions, dyed at a boiling heat. It bears contact with acids much better than does cotton, but it is more readily affected by alkalies, especially at high temperatures. Superheated steam also reduces it to a jelly. The mordants used in wool-dyeing are very frequently added to the dye-pan along with the dye-ware and the goods to be dyed, and all are boiled together,—a procedure rarely admissible with cotton.

A very striking difference between wool and cotton, &c., appears in their respective behaviour with metallic solutions. Thus cotton can be readily dyed a prussian blue by steeping it alternately in solutions of nitrate of iron and of the yellow prussiate of potash. Wool, on the contrary, can only be dyed a prussian blue, or, as it is technically called, a “royal blue”—a class of colour now becoming obsolete—by a circuitous process. Manganese browns and bronzes cannot be satisfactorily produced upon wool. The yellows and oranges got up so readily upon cotton by means of a solution of lead—either acid or alkaline—and the chromate of potash, are here not admissible; amongst

other reasons, because they would be blackened by the sulphur naturally present in wool.

Considerable care is needed in order to obtain level shades on woollen yarns, and still more so upon piece-goods. For this purpose the articles to be dyed are very frequently entered into the dye-liquor at a temperature considerably below the boiling point; they are turned at first with considerable rapidity, and—especially in the case of the aniline dyes—the colour is added in successive portions.

A point which requires more attention in case of woollens than of cottons, is the tendency of the goods to “feed” after having been withdrawn from the dye-beck, and after the process is supposed to be at an end. That is, the colour goes on deepening. If a large mass of wool, of yarn, or of cloth, is lifted out of the dye-beck and laid in a heap, it still retains a high temperature for a considerable time, and it holds between its fibres by capillary attraction a large quantity of the dye-liquor, which in most cases still contains unexhausted colouring matter. In such cases the dyeing process still goes on, and that irregularly. If yarns or cloths are hung up the dye-liquid drains towards the lower ends, and those parts may take a perceptibly darker shade. If wool or yarn is laid in a heap, the liquor drains towards the bottom, and darkens the part where it collects.

This irregular action is combated in various ways. It is sometimes directed in a receipt that the goods should either be let cool in the dye-liquor—the source of heat being of course withdrawn—or washed at once in cold water, so that any further change of colour is at once arrested. These two methods, seemingly opposite, lead in substance to the same result. If the goods are left to cool in the dye-liquor they deepen, indeed, in colour, but uniformly. In some cases it is not safe to wash the dyed goods until they have become cold, and then, of course, the uncombined dye-liquor is removed by wringing or

nipping—whether by hand or mechanically, and by the use of a centrifugal machine.

The state of woollens and the character of the wool have a considerable effect on the quantity of dye-wares to be used. The finer the wool—*i.e.*, the more surface it exposes in a given weight—the greater the proportion of dye-wares required. If a given weight of ware dyes 100 lbs. of loose wool to a given shade, the same weight will serve for 120 lbs. yarn, and for 125 to 130 lbs. piece-goods. The results of dyeing wool in these three different states are by no means alike. When the loose, unspun wool is dyed, every fibre is coloured uniformly all over. Hence the yarns spun and the cloth afterwards woven from such wool are dyed through and through, and do not—supposing the dye to undergo no chemical change from the action of air and moisture—become greyish or whitish by wear and tear. Hence wool-dyeing is preferable for goods which are to stand friction, especially if of a dark colour.

In yarn-dyeing the fibres being in the interior of the thread are not so deeply and fully coloured as those on the outside, and in piece-dyeing, especially in thick, closely woven goods, the interior remains nearly white. This is in certain cases not a disadvantage. Not only is colour economized, but there is a gain in brightness. The thin outer layer of wool which is really coloured, is lighted up by the rays reflected from the white undyed matter below. Delicate and brilliant colours are rarely applied on unspun wool, for the reason that without unusual care—which of course means expense—they are certain to become soiled during the processes of spinning, &c., and cannot be cleaned again without injury to their brightness.

In dyeing mixed goods the usual process is to give the required shade first to the wool or the worsted. The cotton warp is then dyed, usually in the cold, so that the colours applied may not sensibly attach themselves to the wool, and either deepen or modify its shade. The first step in cotton dyeing is generally a working or steeping in

an astringent, which for blacks, &c., is usually myrobalans, sumac, or divi-divi, but for the anilines, pure tannin. The next step is usually the application of an ordinary mordant—iron for blacks, and other sad shades, and preparations of tin for light and bright colours. Both these processes are effected in the cold, and generally by means of the padding-machine, which squeezes the solution into the tissue. Then follows the application of the dye, also in the cold.

In some cases both the worsted and the cotton can be dyed in a single operation.

BLACKS.

Aniline Black on Wool (2 lbs.).

Dissolve 3 ozs. permanganate, and $4\frac{1}{2}$ ozs. Epsoms, in .5 gallons of hot water. When cool enter the wool and let soak till the liquid retains merely a slight yellow colour. Press, and without washing enter in 2 gallons of cold water made up with 12 ozs. aniline oil and 20 ozs. muriatic acid. Press the wool, and wash in a very weak solution of carbonate of soda. Pass into a solution of $\frac{1}{3}$ oz. bichromate of potash in $2\frac{1}{2}$ gallons water, when it takes a deep black. Wash, and dry.

Blue Black on loose Wool (480 lbs.).

Give a medium blue ground in the vat, air, wash, and boil the wool for two hours with 30 lbs. logwood, 50 lbs. sanders, 5 lbs. fustic, and 2 lbs. red argol. Sadden in the same beck with 7 lbs. copperas.

Full Blue Black for Piece Goods (27 lbs.).

Make up a water with 2 lbs. 2 ozs. argol, $6\frac{1}{4}$ ozs. chro-

mate of potash, $3\frac{1}{2}$ ozs. blue-stone, and the same weight of oil of vitriol. Enter at a hand-heat, raise to a boil, and work at that heat for an hour. Lift, rinse, and dry with 24 lbs. logwood, and $3\frac{1}{4}$ ozs. oil of vitriol. Wince for three-quarters of an hour in the boiling liquid, lift, rinse, and dry.

If not blue enough, cool the beck, add 17 ozs. ammonia, stir up, re-enter, and wince for fifteen minutes.

Deep Black on Piece Goods (110 lbs.).

Boil for an hour and a half with $2\frac{3}{4}$ lbs. chromate of potash, $3\frac{1}{4}$ lbs. red argol, and $\frac{1}{2}$ lb. blue-stone. Let cool in the flot, and dye for one hour at a boil with 44 lbs. logwood and 13 lbs. catechu. Lift, add 26 ozs. blue-stone, cool, re-enter, and boil for fifteen minutes longer.

Chrome Black on Wool (55 lbs.).

Boil for an hour and a half with 17 ozs. chromate of potash, the same weight of blue-stone and of oil of vitriol. Lift, and dye in a fresh water with 22 lbs. logwood and $4\frac{1}{4}$ lbs. fustic, boiling for an hour.

Fast Black on Yarns and Cloth (22 lbs.).

Boil for an hour with $9\frac{1}{4}$ ozs. chromate of potash, the same weight of blue-stone, and 8 ozs. oil of vitriol. Let grow cold in the dye-liquor. Dye in a fresh water with $9\frac{1}{4}$ lbs. logwood, $2\frac{1}{4}$ lbs. fustic, and $4\frac{1}{2}$ ozs. sulphate of zinc. Boil for an hour, lift, cool, rinse, and dry. If a very blue shade is required, leave out the fustic.

Black on Wool for Fulling (110 lbs.).

Boil for two hours with logwood 43 lbs., fustic $15\frac{1}{4}$ lbs.,

sumac 13 lbs, red argol $5\frac{1}{2}$ lbs. Replace the water lost by evaporation, and sprinkle the wool with a solution of $5\frac{1}{2}$ lbs. copperas and $3\frac{1}{4}$ lbs. blue-stone, and boil for one hour. For a blue-black sprinkle the wool, when lukewarm, with 4 lbs. 6 ozs. ammonia. For deep jet black, sprinkle with $3\frac{1}{4}$ lbs. bichromate of potash, dissolved in boiling water, and boil for a quarter of an hour.

Black on Knitting Yarns (55 lbs.).

Boil for forty-five minutes with 30 ozs. chromate of potash, $3\frac{1}{2}$ ozs. blue-stone, the same weight of argol, and 7 ozs. sulphuric acid. Take through water, and dye at a boil for forty-five minutes with 33 lbs. logwood.

Black on Wool (160 lbs.).

Boil for one hour and three-quarters with 4 lbs. bichromate of potash, 3 lbs. blue-stone, $\frac{1}{2}$ lb. muriate of tin, $\frac{1}{4}$ lb. oil of vitriol, and 10 lbs. fustic. Dye in a fresh water with 50 lbs. logwood, entering at 170° F., and boiling for one hour.

Another Black on Wool (100 lbs.).

Boil for one hour and a half with $2\frac{1}{2}$ lbs. bichromate of potash and 1 lb. argol.

Dye in a fresh water with the decoction of 30 lbs. logwood, 10 lbs. fustic, 3 lbs. argol, and $\frac{1}{4}$ lb. oil of vitriol.

Enter at 170° F., and boil for one hour.

Another Black on Wool (100 lbs.).

Prepare for two hours at a boil with 8 lbs. copperas, 3 lbs. blue-stone, 3 lbs. argol, and 10 lbs. fustic.

Dye in a fresh water with the decoction of 30 lbs. logwood, entering at 170° F., and boiling for an hour.

Alizarine Black on Wool (100 lbs.).

Prepare with 12 lbs. copperas, 4 lbs. blue-stone, and 4 lbs. red argol, boiling for one hour and a half.

Dye in a fresh water with 7 lbs. alizarine, 44 lbs. logwood, 6 lbs. fustic, 6 lbs. sumac, 3 lbs. chalk.

Black on Thick Half Woollen (10 lbs.).

Dye in the clear decoction of 3 lbs. logwood, $\frac{1}{2}$ lb. sumac, and $\frac{1}{2}$ lb. fustic. Raise to a boil, and keep up for half an hour. Lift, and pass into a cold water with $\frac{1}{2}$ lb. copperas, letting it steep for an hour. Pass into a boiling bath of 2 to 3 ozs. yellow prussiate, and work for an hour. Repeat all these three baths, and rinse well. It is better to rinse each time after the logwood bath.

*Black for Alpaca Yarns containing 30 per cent.
of Cotton (55 lbs.).*

For the mordant, take as little cold water as practicable and add black liquor till it makes 5 $\frac{1}{2}$ ° Tw., and the following substances, which are dissolved separately, each in a small quantity of water, and to the solutions are added:—

Sugar of lead	17 ozs.
Crude red potash	17 „
Copperas	4 lbs. 6 „
Chromate of potash	17 „
Sal-ammoniac	7 „

Let the mixture settle well, and steep the yarns in the

clear for one hour and a half. Lift, whiz, dry rapidly, take through a weak soda bath, and dye in a fresh water with:—

Logwood	.	.	.	.	.	17½ lbs.
Fustic	.	.	.	.	.	4 lbs. 6 oz.

Black for Mixed Goods (100 lbs.)

Boil 40 lbs. logwood, 10 lbs. fustic, 20 lbs. sumac, 3 lbs. red argol. Cool, enter, and boil for an hour.

Lift, and add add 6 lbs. copperas and 4 lbs. blue-stone. Boil again for an hour; lift, cool down, and tone in the same water with 5 lbs. ammonia and 2 lbs. soda-ash.

BLUES.

Logwood Blue (100 lbs.).

Give a ground in the vat, wash, and mordant at a boil for one hour and a half with 8 lbs. alum, 5 lbs. sulphate of copper, 6 lbs. tin crystals, 4 lbs. bichromate of potash, 2 lbs. argol, and 2 lbs. sulphuric acid.

Dye in a fresh water with 20 lbs. logwood and 4 lbs. Santa Marta wood, without bringing to a boil.

Logwood Blue Process in use at Aix-la-Chapelle (100 lbs.).

Boil for two hours with 13 lbs. alum, 6½ lbs. argol, 2½ lbs. tin crystals, and ½ lb. sulphuric acid.

Let the wood lie for a night, and then dye with 40 lbs. logwood and 1 lb. carbonate of soda crystals.

Logwood Blue Process in use at Verviers (100 lbs.).

Boil for two hours with 10 lbs. alum and 1 lb. bichromate of potash.

After boiling, let the wool lie over-night, and dye in the morning with 20 lbs. logwood.

Logwood Blue, Dutch Process (100 lbs.).

Boil for two hours and a half with 5 lbs. sulphate of alumina, 4 lbs. chrome-alum, and 1 lb. blue-stone.

Let lie over-night, and dye the next morning with 6 lbs. extract of logwood, and 1 lb. carbonate of soda.

Dark Blue on Cloth (110 lbs.).

Boil for an hour with $5\frac{1}{2}$ lbs. alum, $2\frac{3}{4}$ lbs. red argol, 17 lbs. chromate of potash, and $2\frac{3}{4}$ lbs. bichloride of tin. Let cool in the flot.

Dye for one hour at a boil with 22 lbs. logwood and 11 lbs. extract of indigo.

Extract Blue on Wool and Cloth (55 lbs.).

Make up a water with 17 ozs. sulphate of soda, the same weight of oil of vitriol, and from 7 to 17 ozs. extract of indigo. Boil up, cool, enter, then turn continually to shade at a boil.

Nicholson Blue (50 lbs.).

Make up a water with 1 lb. borax and 7 ozs. Nicholson blue.

Enter at 170° F., give four to five turns, and raise to a boil, turning to shade. Wash, and raise colour in a water acidulated with sulphuric acid. Wash and dry.

Methylene Blue (100 lbs. Wool).

Mordant for one hour and a half with $2\frac{1}{2}$ lbs. bichromate of potash and 2 lbs. argol, at a boil.

Dye in a fresh water with 1 lb. methylene blue O O (of the Baden Aniline Company), boiling for three-quarters of an hour, and letting the wool afterwards steep in the hot liquor for four to eight hours. This shade stands fulling.

Blue on Wool and Cloth (44 lbs.).

Boil for an hour with $5\frac{1}{2}$ lbs. alum, $5\frac{1}{2}$ lbs. argol, 1 lb. oxalic acid, $\frac{1}{2}$ lb. tin crystals. Dye in a fresh beck with $6\frac{1}{2}$ to 11 lbs. logwood.

Nemours Blue on Cloth (11 lbs.).

Boil for one hour and a half with $4\frac{1}{2}$ ozs. chromate of potash, $\frac{3}{4}$ to $1\frac{1}{4}$ oz. oil of vitriol, and $8\frac{3}{4}$ ozs. argol. Let cool in the liquor, rinse, and dye with $4\frac{1}{2}$ to $5\frac{1}{2}$ lbs. logwood, 1 lb. sanders, and $\frac{1}{4}$ lb. fustic, boiling for an hour.

Aniline Blue on Yarns to bear Fulling (55 lbs.).

Make up a water for $5\frac{1}{2}$ lbs. sulphate of alumina, $4\frac{1}{4}$ lbs. sulphate of soda, $26\frac{1}{2}$ ozs. tartar, 17 ozs. perchloride of tin, and the clear solution of 3 ozs. aniline blue. Boil up, enter the yarns, and dye at a boil. Take out, whiz, and rinse.

Guernsey Blue on Flannel (100 lbs.).

Boil up 30 lbs. barwood, cool, enter the flannel, and boil for three-quarters of an hour.

Then dissolve in a water 2 lbs. Guernsey blue and $1\frac{1}{2}$ lb. sulphate of zinc.

Enter the flannel at a hand-heat, raise slowly to a boil, and boil for two hours. Lift, rinse well in cold water, and raise the shade in a bath containing $1\frac{1}{2}$ lb. sulphate of zinc, and 8 lbs. oil of vitriol. Rinse, and dry.

Prussiate Blue on Worsted (100 lbs.).

Dissolve in separate vessels, and in cold water:—

9 lbs. red prussiate.
 $2\frac{1}{2}$ „ tartaric acid.
 $2\frac{1}{2}$ „ oxalic acid.
2 „ tin composition.

When well dissolved pour together, and stir well.

Add the above mixture to a water at 100° F., and then add 12 lbs. good oil of vitriol.

Enter the goods, turn well, heat slow up to the boiling point, and boil for half an hour.

For darker shades add the decoction of 14 lbs. logwood chips and a few pounds of muriate of tin. Cool the dye before re-entering the goods, and turn very quickly to get a level shade.

For a finer shade leave out the logwood, rinse well, and top in a fresh cold bath with a little aniline blue.

Fast Blue without Indigo (120 lbs.).

Boil for two hours with 3 lbs. blue-stone, 3 lbs. oxalate of potash, 15 lbs. alum, 6 lbs. argol, and 2 lbs. chrome. Let cool in the flot, and dye in a fresh water with 50 lbs. logwood, boiling for two hours.

Dark Gendarme Blue on Worsted (50 lbs.).

Add to a water 1 lb. borax, 3 ozs. Nicholson blue, and 6 ozs. alkali green (Meister, Lucius, and Bruening, of Hoechst).

Enter at 160° F., turn for ten minutes while raising to a boil, and boil for half an hour.

Enter in a fresh water at 130° F., with $\frac{3}{4}$ lb. oil of vitriol. Give four or five turns, and wash.

Dark Navy Blue on Worsted (50 lbs.).

Dissolve 10 lbs. sulphate of soda, 2 lbs. induline, 2 lbs. extract of orchil, and 6 lbs. extract of indigo, and add 2 quarts oil of vitriol. Enter at 180° F., turn continually, raising to a boil, and boil to shade.

Dark Sapphire on Worsted (50 lbs.).

Give a Guernsey blue bottom in the usual manner, with 6 ozs. Guernsey blue; wash, and raise in a water with 2 lbs. sulphuric acid.

Dissolve in a fresh water 3 lbs. sulphate of soda, $\frac{1}{2}$ lb. argol, 1 lb. alum, 3 lbs. indigo extract, and $1\frac{1}{2}$ lb. picric acid.

Blue on Yarn (100 lbs.).

Make up water at 160° F., with 10 lbs. sulphate of soda, 2 lbs. oil of vitriol, 1 lb. "soluble blue R.S." (Monnet and Co., of Geneva). Enter, turn to shade whilst raising to a boil; wash and dry.

Blue on Coarse Woollen Yarns (55 lbs.).

Indigotine for dark colours (Fränkel and Runge, of Berlin)

Orange (Baden Anilin Co.)	10 $\frac{1}{4}$ ozs.
Methyl violet	1 $\frac{1}{4}$ "
	$\frac{1}{4}$ "

Dissolve well, and add to the water.

Add further:—

Oil of vitriol.	.	.	.	2 lbs. 3 ozs.
Sulphate of soda	.	.	.	5½ lbs.
Red argol	.	.	.	8¼ ozs.

Enter yarns at 122° F., and boil for an hour.

Benzyl Blue.

Dissolve in 100 to 200 parts of water, and dye at a boil without any mordant.

Navy Blue for Ladies' Cloth (44 lbs.).

First bath 4 lbs. soda and $\frac{3}{4}$ lb. Prussian blue, in which the cloth is turned for an hour at 200° F.; it is then washed and placed in a second water, strongly soured, and containing 10 ozs. methyl violet. Finish below the boiling heat.

Marine Blue on Mixed Goods (22 lbs.).

Give a ground with Nicholson blue, working for half an hour at a boil, with $4\frac{1}{2}$ ozs. Nicholson blue of the reddest shade and $8\frac{1}{2}$ ozs. soda crystals.

Rinse slightly, and raise in a fresh hot water with $10\frac{1}{2}$ ozs. oil of vitriol, and bring up to shade in the same water with a little orchil liquor and picric acid.

After the wool or worsted has thus been dyed, the goods are steeped over-night in a lukewarm solution of $3\frac{1}{2}$ ozs. tannin, and then worked for half an hour in a cold solution of aquafortis at $1\frac{1}{2}$ ° Tw. Dye to shade with bluish methyl violet and a little extract of logwood, souring lastly with a little vitriol.

Puteaux Blue (on Woollen Cloth or Yarns), 100 lbs.

The dyeing is done in wooden or stone tanks, the use of copper being entirely avoided. Steam is introduced by a leaden pipe.

Put into the water 3 lbs. oxalic acid, and boil for fifteen minutes. Stop boiling, and add 4 to 5 lbs. ammonia and 10 lbs. dye. Re-enter the goods, and boil for three-quarters of an hour; the bath should then be of a light violet; add 3 to 4 lbs. oxalic acid, and dye in an hour and a half. The dyeing can be hastened by adding 1 to 2 lbs. more oxalic or acetic acid.

After dyeing immerse the goods in water and steep for fifteen minutes in a water at 122° F., containing 4 lbs. acetate, sulphate, or chloride of zinc, with 2 lbs. acetic, sulphuric, or muriatic acid.

Wash as usual. If the wool is to be fulled after dyeing, instead of the zinc process boil it for ten or twenty minutes with 3 to 4 lbs. ground galls and 1 to 2 lbs. acetic acid.

Navy Blue on Mixed Goods (10 lbs.).

Boil with 3 ozs. each argol and chromate of potash. Rinse, prepare with 2 lbs. sumac, and dye at a gentle boil with 1 lb. logwood and $\frac{1}{4}$ oz. aniline violet. Lift and work at a hand-heat for half an hour in a water with 2 lbs. logwood. Lift, drain, and sadden in a fresh water with $\frac{1}{2}$ lb. blue-stone. Lift, and rinse well.

Or: prepare with 2 lbs. sumac, drain, take through black liquor at 2 $\frac{1}{2}$ ° Tw., rinse, and finally dye at a hand-heat with 2 $\frac{1}{2}$ ozs. methyl violet.

Vat Dyeing on Wool.

Indigo is very extensively applied to wool and woollen

goods by means of the warm or fermentation vat. Of this there are several modifications.

The Indian, or potash-vat, is set with bran, madder, potash, and indigo. The last ingredient is only added after the vat has been heated up to 194° F. The working heat is only between 86° and 104° F., and is kept up by a gentle passage of steam through the pipes. For the first forty-eight hours the mixture is stirred thoroughly up once in twelve hours. The proportions of the wares are indigo 17½ lbs., potash 26 lbs., bran and madder 7½ lbs. each. When in working order the liquid has a greenish-yellow colour, with a bluish scum on the surface. This vat requires to be refreshed every twenty-five to thirty days with additional doses of potash, indigo, and madder.

The German vat is under many circumstances preferable to the Indian. The water is first heated up to 203° F., and the wares are then added in the proportion of 20 pails of bran, 24 lbs. carbonate of soda, 13 lbs. indigo, and 6½ lbs. of freshly slaked lime. The mixture is kept at a higher temperature than the Indian vat, viz., from 104° to 122° F. Fermentation begins in about twelve hours; the liquid takes a greenish-blue, with a sourish smell, and bubbles of gas escape. After the lapse of three days the vat may be set to work. It requires refreshing from time to time with indigo, soda, and lime in the original proportions, to which small quantities of treacle are also added. With careful management such a vat may remain in good order for two years.

The method of working is as follows:—The vats are stirred up early in the morning, and skimmed. A bag-net, made of strong twine, and supported by a wooden hoop, is let down into the liquid, and within this the wool is dyed, so that it may not come in contact with the sediment at the bottom. The time of immersion is generally about twenty to thirty minutes. The goods when lifted appear of a greenish-yellow, and are rendered blue on exposure to the air, which re-oxidizes the indigo. If the shade is not deep

enough the goods are returned to the vat. When sufficiently deep, the goods are washed, first with weak vitriol sours, to remove lime and alkali, and then with a large quantity of water.

In setting the fermentation vat, the indigo requires to be reduced to a uniform pulp, just as in the cold or copperas vat.

Fermentation vats are liable to diseases, probably due to the development of microscopic organisms—a subject worth the attention of the student,—but connected the one with an excess, and the other with a deficiency of lime. In the former case the liquid grows clearer and brighter, the smell ceases, and all marks of fermentation disappear, the indigo being precipitated to the bottom of the vat. An addition of copperas, applied in time, acts here as a remedy.

If the lime is deficient the fermentation takes a putrid form, the liquid turns red, and instead of dyeing cloth it strips the colour of such as is already dyed. A heat of about 204° F., and an addition of lime, sometimes arrests this disease; very frequently, however, the vat is lost.

The new vat of Schützenberger and Lalande is applicable to wool and silk as well as to cotton or linen.

“New Royal Blue” (36 lbs.).

The subjoined receipt is for the richest prussian blue capable of being obtained upon wool, though it has now little more than a historical interest:—

Dissolve 4 lbs. prussiate of potash and 6 lbs. oxalic acid. Enter the wool or yarns at 100° F., and work well for two hours, raising the heat gradually to 180° F., lift, and cool. Cool the liquor with two pails of cold water, add 21 lbs. alum, and work for half an hour. Add $\frac{3}{4}$ pint yellow spirit, and work for an hour, raising to 180° F., at which heat work for one hour and a quarter longer.

Lift, and add 1 or 2 pints of nitrate of iron, according to

shade required. Enter the goods, and give five or six turns. Take out, cool, and wash very well. If a very dark shade is required, add a little logwood along with the nitrate of iron.

Yellowish Brown on Wool (328 lbs.).

Boil for one hour and a quarter with $6\frac{1}{2}$ lbs. chromate of potash, 2 lbs. 2 ozs. sulphuric acid, $4\frac{1}{4}$ lbs. alum, $8\frac{3}{4}$ ozs. oxalic acid, and $4\frac{1}{2}$ ozs. tin crystals.

Boil in a fresh water 98 lbs. fustic, 4 lbs. 6 ozs. logwood, 32 lbs. turmeric, and 27 lbs. madder. Cool, enter the wool, and boil for an hour. Sadden in the same water with 2 lbs. 3 ozs. copperas and 17 ozs. blue-stone, boiling for fifteen minutes longer.

Reddish Brown on Wool (110 lbs.).

Mordant as in the last receipt. Boil up in a fresh water 48 lbs. fustic, 32 lbs. madder, 8 lbs. 2 ozs. each camwood and sanders, and $5\frac{1}{2}$ lbs. sumac.

Cool, enter the wool, and work for an hour, gradually raising to a boil. Sadden in the same water with 2 lbs. $7\frac{1}{2}$ ozs. copperas, boiling for twenty minutes.

Bronze on Cloth (45 lbs.).

Boil for one hour and a half with $5\frac{1}{2}$ lbs. alum, $2\frac{3}{4}$ lbs. argol, and the same weight of blue-stone. Lift, and dye at a boil for one hour in a fresh beck, with 32 lbs. fustic, $2\frac{3}{4}$ lbs. logwood, and $13\frac{1}{4}$ lbs. madder. Take out and sadden with $3\frac{1}{4}$ lbs. copperas, or more, according to shade.

Light Brown on Yarn (110 lbs.).

Boil for one hour and a half with 27 ozs. chromate of

potash, 17 ozs. argol, and 14 ozs. alum. Dye at a boil for an hour, with 35 lbs. fustic, $8\frac{1}{2}$ lbs. camwood, and $\frac{1}{2}$ lb. madder.

Brown on Yarn (110 lbs.).

Boil for one hour and a half with 27 ozs. chromate of potash, and an equal weight of argol. Lift, and dye at a boil, with 44 lbs. fustic, 35 lbs. camwood, and 11 lbs. logwood.

Dark Brown (54 lbs.).

Give a rather full ground in the vat, and boil for two hours in a water with alum 22 lbs., argol $6\frac{1}{2}$ lbs., copperas 26 ozs., and fustic 17 lbs. Lift, cool, and dye hot, but not boiling, with 66 lbs. logwood and 13 lbs. sumac. At the end of an hour add $4\frac{1}{4}$ lbs. copperas. Wash in water containing a little soda, and, lastly, in pure water.

Golden Bronze (54 lbs.).

Boil for two hours in a water with fustic 26 lbs. sumac and sanders 13 lbs. each. Lift, add copperas $6\frac{1}{2}$ lbs., and blue-stone $4\frac{1}{4}$ lbs. Re-enter, and boil for half an hour, and rinse.

Olive Bronze (54 lbs.).

Give a half shade in the vat, and dye with argol $6\frac{1}{2}$ lbs., blue-stone $4\frac{1}{4}$ lbs., fustic 87 lbs., sanders and turmeric 11 lbs. each, madder extract $6\frac{1}{2}$ lbs. Boil two hours, lift, and wash. Add to the bath $6\frac{1}{2}$ lbs. copperas dissolved, and re-enter. Lastly, pass through water containing a little carbonate of soda, and rinse in plain water.

Metallic Lustre on Browns (44 lbs.).

Take the dyed cloth through a water at 150° F., with $6\frac{1}{2}$ lbs. blue-stone, and $16\frac{1}{4}$ lbs. ammonia. Rinse slightly, and take through a water, with 13 lbs. hyposulphite of soda.

Brown on Yarn (55 lbs.).

Boil for forty-five minutes, with 30 ozs. chromate of potash. Take through water the day after, and dye with 26 lbs. peachwood and 34 ozs. fustic. For very pale shades 3 ozs. sulphate of alumina may be added to the beck. For very dark shades, sadden with logwood.

Golden Brown on Cloth (110 lbs.)

Boil out 88 lbs. fustic, and add to the decoction 27 lbs. calliatura wood, $8\frac{3}{4}$ lbs. turmeric, and $5\frac{1}{2}$ lbs. argol. Boil for an hour, lift, add $5\frac{1}{2}$ lbs. blue-stone, boil for half an hour, lift, and sadden with 5 ozs. copperas.

Reddish Brown on Wool (10 lbs.).

Prepare at a boil with $\frac{1}{4}$ lb. bichromate of potash, 2 ozs. oil of vitriol, 1 lb. alum, for one hour and a half. Dye at a boil for one hour with 3 lbs. redwood, 1 lb. camwood, 1 lb. fustic.

Brown on Wool (100 lbs.).

Boil for an hour and a half in a water with 2 lbs. bichromate of potash and 2 lbs. argol.

Boil in a fresh water in a bag 40 lbs. fustic. Take out the bag, and add to the water—

20 lbs. camwood.
7 lbs. madder.
7 lbs. cutch.

Boil for fifteen minutes longer; cool, enter the prepared wool, and boil one hour. Sadden with $1\frac{1}{2}$ lb. each copperas and blue-stone, and boil for twenty minutes longer.

Brown on Alpaca (10 lbs.).

Dissolve 1 lb. alum.
,, $\frac{3}{4}$ lb. argol.
,, $\frac{3}{4}$ lb. cudbear.

Boil for twenty minutes; cool, enter the goods, and boil for an hour; lift, and rinse.

Enter the goods in another hot water with the decoction of 4 lbs. cutch. Give six turns (or, as it is often called, six "ends"). Lift, and pass into another hot water containing solution of 1 lb. bichromate of potash; give six turns, lift, drain, and pass back into the cutch bath. Rinse, and finish with the decoction of 4 lbs. redwood.

A darker shade is got by giving the goods a little logwood after the redwood bath. Work the goods in the logwood bath for an hour at a boil. Lift, and add to the same bath 1 oz. tin crystals and 1 oz. oil of vitriol. Re-enter the goods, six turns, rinse, and dry.

Brown on Worsted (100 lbs.).

Prepare with a solution of 2 lbs. bichromate of potash, 2 lbs. argol, and 1 lb. tin crystals. Boil for two hours, turning well, lift, and wash.

Boil in a fresh water for an hour, in a bag—

10 lbs. redwood.

40 lbs. fustic.

4 lbs. logwood.

Take out the bag, and add to the same bath—

10 lbs. cutch.

10 lbs. camwood.

16 lbs. madder.

2 lbs. argol.

Let boil fifteen minutes longer, cool, and enter the cloth, turning well, and boiling for an hour. Lift, and add to the same bath 2 lbs. each copperas and blue-stone. Cool the dye after these ingredients are dissolved. Enter, turn well, and boil for fifteen minutes.

Brown on Shoddy containing Cotton (100 lbs.).

Boil for half an hour 30 lbs. fustic, 3 lbs. alum, prepared tartar 2 lbs., and blue-stone 1 lb. Add to the liquor 1 lb. bichromate of potash and 12 ozs. magenta. Enter, boil very gently, sadden with logwood, and tint with turmeric if required.

Gold Brown on Worsted (50 lbs.).

Dissolve 3 lbs. alum, 1 lb. tartar, 3 lbs. sulphuric acid, 12 ozs. fast yellow, 5 ozs. "orange A," 1 oz. "fast red R" (all these three colours from the Baden Aniline Co.), 4 ozs. extract of indigo. Enter at 180° F., and turn till even.

Alizarine Brown (100 lbs.).

Mordant with 3 lbs. bichromate of potash, and $\frac{1}{2}$ lb. blue-stone, boiling for one hour and a half.

Enter in a fresh water with 5 lbs. alizarine, 9 lbs. extract of fustic, 6 lbs. sumac, and boil for one hour and a half. Sadden with 2 lbs. copperas, and boil for half an hour; then leave in the liquor for four hours.

Maroon with Alizarine (100 lbs.).

Mordant at a boil for two hours with $1\frac{1}{2}$ lb. bichromate of potash and 2 lbs. red argol. Enter in a fresh water with 13 lbs. alizarine, 6 lbs. sumac, and 2 lbs. chalk.

The shade may be modified by leaving out some or all of the sumac.

Dark Brown on Worsted (75 lbs.).

Boil 2 lbs. alum, 10 lbs. sulphate of soda, and 4 ozs. red argol with 18 ozs. "maroon, S," 8 ozs. "fast yellow," and 2 ozs. "orange A" (all three of the Baden Aniline Co.), and 12 lbs. extract of indigo.

Enter at 180° F., raise to 212° F., and boil for one hour.

Red Brown on Wool (50 lbs.).

Boil 6 lbs. sulphate of soda, $2\frac{1}{2}$ lbs. alum, 4 ozs. "orange II," and 6 ozs. "claret red" (both of the Farbwerke, Hoechst on the Main), and 5 lbs. extract of indigo.

Enter at 160° F., turn well, raise to a boil, and dye to shade.

If the "orange II" is reduced or omitted, a more purple tone is obtained.

Maroon on Yarn (100 lbs.).

Chromate of potash	.	.	.	.	2 lbs.
Ground fustic	.	.	.	.	$6\frac{1}{4}$ lbs.

Ground logwood	.	.	.	.	$1\frac{9}{16}$ lbs.
Ground sanders	.	.	.	.	60 lbs.
Turmeric	.	.	.	.	2 lbs.

Mordant in the chrome bath for two hours, and leave the yarn in flat heaps in a cool, dark place till morning. Wash, and enter in the dye-beck at 158° — 167° F., and do not push to a boil till the shade appears even. Boil for one hour and a half. Wash off at once after dyeing.

Darker shades may be produced by increasing the quantities. If orchil is substituted for sanders, the quantity of fustic must be a little increased, as orchil gives a cherry red with chrome.

Dead Leaf (55 lbs.).

Prepare at a boil with bichromate of potash 17 ozs., argol 2 lbs. 2 ozs. Dye with catechu $6\frac{1}{2}$ lbs., young fustic $4\frac{1}{4}$ lbs., logwood $2\frac{1}{4}$ lbs.

Very Dark Olive Brown on Half Woollen Reps (22 lbs.).

The wool is first dyed as follows:—Boil with argol $8\frac{1}{4}$ ozs., madder 7 ozs., extract of fustic $2\frac{1}{4}$ ozs., sumac $8\frac{3}{4}$ ozs., for forty-five minutes. Sadden in the same beck with $1\frac{1}{4}$ oz. copperas.

Finally, dye to shade with picric acid and logwood.

Steep over-night in a strong, lukewarm decoction of fustic, and work for an hour in a cold nitrate of iron at $2\frac{1}{2}^{\circ}$ Tw. Rinse, and dye in the cold with decoctions of fustic and logwood.

Chrome Puce on Woollen Reps (22 lbs.).

Boil the goods for one hour and a half with bichromate of potash $8\frac{1}{4}$ ozs., sulphuric acid, $\frac{3}{4}$ oz. Let lie over-night,

and dye, without rinsing in a fresh beck, with extract of fustic 14 ozs., extract of logwood $3\frac{1}{2}$ ozs., madder 14 ozs., calliatura wood, $5\frac{1}{4}$ ozs. Boil for half an hour; darken with the decoction of 17 ozs. logwood, and finally sadden, without boiling, with $\frac{3}{4}$ oz. to 1 oz. copperas.

Fast Brown on Mixed Goods with Linen Warps
(260 lbs.).

Wash with soda-crystals and boil with argol $15\frac{1}{4}$ lbs., and alum $16\frac{1}{4}$ lbs.

Keep at the boil for an hour; lift, cool, rinse, and dye with 66 lbs. madder, boiling for half an hour. Sadden with 33 lbs. logwood.

To dye the linen, work for two hours at 150° F. in a decoction of 44 lbs. prepared catechu; lift, and enter in a boiling water with $3\frac{1}{2}$ lbs. bichromate.

Rinse and sadden, if needed, in a fresh water with 17 lbs. logwood. The tone may be modified by adding a little acid magenta.

Chamois (11 lbs.).

Make up a water with $6\frac{1}{4}$ ozs. oxalic acid, $3\frac{1}{3}$ ozs. tin crystals, 1 to $1\frac{1}{4}$ oz. cochineal, and a trace of flavine. Boil up, cool, enter, and dye to shade, raising rapidly to a boil.

Cinnamon on Yarns (110 lbs.).

Boil for one hour and a half with 20 ozs. chromate of potash, 14 ozs. argol, 27 ozs. alum; and dye by boiling for an hour with 22 lbs. camwood, $3\frac{1}{2}$ ozs. madder, and $6\frac{1}{2}$ lbs. fustic.

Cinnamon on Yarns (55 lbs.).

Boil up $6\frac{1}{4}$ lbs. orchil, $2\frac{1}{4}$ lb. extract of bark, 9 ozs. tur-

meric, $2\frac{1}{4}$ lbs. alum, $2\frac{1}{4}$ lbs. argol, 8 ozs. blue-stone. Cool, enter yarns, and boil for half an hour. Lift, add 8 ozs. oil of vitriol, and boil for fifteen minutes longer.

Cinnamon on Wool (100 lbs.).

Boil for ninety minutes with 10 lbs. extract of fustic and 50 lbs. sanders. Sadden with $1\frac{1}{4}$ lb. blue-stone, and boil for another hour. Cool, add 5 jugs of lant (stale urine), and let the wool steep for an hour.

Drab on Yarn (110 lbs.).

Boil for an hour with 2 lbs. 3 ozs. logwood, $\frac{1}{2}$ lb. fustic, and the same weight each of camwood, copperas, and argol.

Drab on Cloth (110 lbs.).

Boil together $3\frac{1}{4}$ lbs. sumac, $6\frac{1}{2}$ lbs. madder, with the decoction of $3\frac{1}{2}$ ozs. sanders, and 6 ozs. fustic. Add $3\frac{1}{4}$ ozs. argol, cool, enter, boil for an hour, and sadden with $1\frac{1}{4}$ ozs. copperas.

Dark Drab on Wool (50 lbs.).

Boil 4 lbs. of peachwood, 5 lbs. fustic, and 2 lbs. logwood. Take out the ware, cool, enter the goods, and boil for one hour and a quarter, and sadden with copperas.

Silver Drab on Wool (100 lbs.).

Boil out in a water $1\frac{1}{3}$ lb. ground logwood, and $\frac{2}{3}$ lb. orchil. Enter, boil for seventy-five minutes, sadden with 3 ozs. copperas, and boil for twenty minutes more.

Dark Fawn Drab on Worsted (50 lbs.).

Dissolve at a boil 1 lb. red argol, 3 lbs. alum, 2 lbs. oil of vitriol, 2 lbs. extract of indigo, $\frac{1}{4}$ lb. extract of orchil, 2 ozs. "orange Y" (Levinstein and Co., Manchester). Cool to 180° F., give ten turns, and wash.

Green (100 lbs. wool).

Boil for ninety minutes with 3 lbs. bichromate of potash and 3 lbs. sulphate of soda crystals.

Make up a fresh water with 15 lbs. viridine (Baden Anilin Fabrik), and 10 lbs. sumac.

Enter at 160° F., raise to a boil, and keep at that temperature for one hour.

This colour bears fulling, and is not affected by acids and light.

Acid Green (50 lbs. yarn).

Mordant for an hour at 180° F., with 2 lbs. hyposulphite of soda, and 2 lbs. muriatic acid. Lift, and take through a water with $2\frac{1}{2}$ ozs. ammonia.

Make up a water at 120° F. with 8 ozs. acid green F. II. (Bindschedler and Busch, of Bâle), and turn to shade, raising the heat to a boil. Lift, wash, and dry.

Light Green (100 lbs. wool).

Mordant at a boil with $2\frac{1}{2}$ lbs. bichromate of potash, and 2 lbs. tartar, for 90 minutes.

Dye in a fresh water with 1 lb. methylene blue and 1 lb. extract of fustic. Boil for forty-five minutes, and let steep for four to eight hours.

Iodine Green on Cloth.

Enter the cloth in a bath made slightly alkaline with ammonia for two or three hours. Wash, and take through weak vitriol sours. Enter in colour bath, and dye to shade. The longer the bath is used the finer are the shades dyed.

Or on wool (30 lbs.):—

Wash clean, put in a water with 3 ozs. stannate of soda and $1\frac{1}{2}$ oz. iodine green powder, previously dissolved in boiling water. Enter the wool, and boil for forty-five minutes, lift, and enter in a fresh water which has been cleared with a little tin crystals, and to which 2 lbs. oil of vitriol has been added, and work to shade at a boil.

Fast Green on Wool (219 lbs.).

Prepare at a boil for one hour and a half with 19 lbs. sulphate of alumina, $4\frac{3}{4}$ lbs. chromate of potash, the same weight of oil of vitriol, and 26 ozs. tin crystals.

Boil up in the dye-pan 1 lb. sulphate of alumina, and remove scum if needed, add 46 lbs. acid extract of indigo, 18 ozs. French extract of fustic, and 1 lb. salt. Boil for one hour and a half to two hours.

Bottle Green (219 lbs.).

Boil for an hour and a half with $6\frac{1}{2}$ lbs. bichromate of potash and $3\frac{1}{4}$ lbs. argol, and dye at a boil for the same length of time in a water made up with $8\frac{3}{4}$ lbs. French extract of fustic, 2 lbs. 2 ozs. extract of logwood, and $17\frac{1}{2}$ lbs. madder.

Sadden with 20 ozs. copperas, and boil for half an hour longer.

Green on Yarn (11 lbs.).

Add to a water 26 ozs. ground fustic, boil up, remove the wood, dissolve $3\frac{1}{4}$ lbs. alum and 1 lb. argol in the bath, stir well up, and add 3 ozs. extract of indigo, let dissolve, cool, enter yarn, and dye for half an hour at a boil.

Aurantine Green (128 lbs. yarn or wool).

Dissolve 10 lbs. alum, 4 lbs. extract of indigo, 2 lbs. tartar, 4 lbs. oil of vitriol, 5 lbs. salt, to 1 lb. aurantine. The aurantine is dissolved separately in 2 gallons water with 3 ozs. of tin crystals. When dissolved, add to the dye-beck.

Cool, enter, raise to a boil, and dye to shade.

Green on Shoddy (100 lbs.).

Boil with 12 lbs. alum, 2 lbs. chromate of potash, 2 lbs. common salt, 1 lb. tin crystals, and 2 lbs. oil of vitriol.

Dye in a fresh water made up with 4 lbs. alum, 2 lbs. common salt, 5 lbs. extract of indigo, and 2 lbs. fustic.

Brilliant Green on Wool (55 lbs.).

Dye with 8 ozs. Nicholson blue and 34 ozs. borax. After two hours a sample is plunged into dilute sulphuric acid to see if the shade has been reached. As soon as this point is gained, the goods are drained and plunged into a water containing 26 ozs. sulphuric acid and $5\frac{1}{4}$ ozs. picric acid.

Green on Worsted (25 lbs.).

Dissolve 3 ozs. new acid green (F. Bayer and Co., of

Barmen), 3 lbs. sulphate of soda, $\frac{1}{2}$ lb. oil of vitriol. Clear the liquid, if needful, enter at 150° F., turn briskly, and raise slowly to a boil.

The green should be dissolved in the cold.

Dark Peacock Green on Worsted Yarn (25 lbs.).

Dye in an alkaline bath with 2 ozs. Nicholson blue and 3 ozs. Victoria green (Baden Aniline Co.), for three-quarters of an hour. Lift, rinse, and finish in sours at 150° F., giving five turns.

Dark Green on Flannel (100 lbs.).

Mordant with $2\frac{1}{2}$ lbs. bichromate of potash and 2 lbs. tartar, boiling for one hour and a half. Dye in a fresh water with $1\frac{1}{2}$ lb. methylene blue O (Baden Aniline Co.), and $1\frac{1}{2}$ lb. each extracts of logwood and fustic, boiling for three-quarters of an hour.

Fast Dark Green on Wool (100 lbs.).

Boil for one hour and a half with $1\frac{1}{4}$ lb. bichromate of potash, $\frac{3}{4}$ lb. tin crystals, 8 lbs. alum, and 1 pint oil of vitriol.

Enter in a fresh water with 15 lbs. extract of indigo, 2 lbs. extract of fustic, 4 lbs. alum, and 4 lbs. salt. Boil till level.

Olive Green on Wool (100 lbs.).

Add to a boiling water 1 lb. "new yellow," 4 ozs. "orchil substitute" (both of Lutz and Moebius, New York), $2\frac{1}{2}$ lbs. extract of indigo, 8 lbs. sulphate of soda, 3 lbs. oil of

vitriol, and 2 lbs. alum. Work the yarn at a boil for one hour and a quarter.

Etincelle Green on Woollen Yarn (100 lbs.).

Prepare for an hour in a water at 180° F., containing 8 lbs. hyposulphite of soda and 8 lbs. muriatic acid.

Lift, and wash in a fresh water, cold, with 4 ozs. ammonia.

Make up a fresh water at 120° F., with 1 lb. "green etincelle" (Monnet and Co., of Geneva).

Enter yarn, turn to shade, raising temperature to a boil, lift, wash, and dry.

The "solid greens" J and J 4 of the same firm, are dyed in the same manner.

Emerald Green on Worsted (50 lbs. yarn).

Dissolve in very pure water 6 ozs. "emerald green" (Baden Aniline Co.) and 4 ozs. oil of vitriol.

Enter at 160° F., and turn constantly whilst raising temperature to 180° F.

Sea-Green on Coarse Woollen Yarn (55 lbs.).

Make up a water with:—

Prepared tartar	8 lbs.
Sulphate of soda	2 lbs.
Argol	8 $\frac{3}{4}$ ozs.

Dissolve separately in a pot:—

Light green (Baden Aniline Co.)	$\frac{7}{8}$ oz.
Indigotine	1 $\frac{3}{4}$ oz.
Cochineal waste	5 to 7 ozs.

Imperial Green.

To dissolve the colour (of G. Dore and Co., of Frankfort-on-the-Main), add the colour along with an equal weight of acetic acid at $9\frac{1}{2}^{\circ}$ Tw., to about ten times its weight of hot water. Raise to a boil, and filter. Enter at 140° F., and gradually raise to a boil. The addition of more acetic acid gives a bluer tone, whilst picric acid, with a very little sulphuric, turns it yellower.

Dark Steel Green on Half Woollens (56 lbs.).

Mordant for an hour at a boil with $8\frac{1}{2}$ ozs. chromate of potash, 7 ozs. oil of vitriol, and the same weight of tin crystals. Let the goods lie over-night, and dye in a fresh water with 19 ozs. extract of indigo, $4\frac{1}{2}$ ozs. extract of fustic, and 14 ozs. extract of logwood, boiling for half an hour. They are then, if needful, brought up to shade with a little decoction of logwood, steeped over-night in a lukewarm solution of $8\frac{1}{2}$ ozs. tannin, taken through cold black liquor at $1\frac{1}{4}^{\circ}$ Tw. for half an hour, aired, rinsed, and cotton-dyed in the cold with the solution of 7 ozs. methyl green B, $1\frac{1}{2}$ ozs. extract of fustic, and the same weight extract of logwood.

Methyl Green on Wool (220 lbs.).

For mordanting, take 875 gallons water, hyposulphite of soda 44 lbs., alum 22 lbs., oil of vitriol 13 lbs. The acid must not be added to the water till the alum and the hyposulphite are dissolved.

Enter the wool at 140° F. For piece goods raise the heat by degrees to a boil, after having kept it for about half an hour between 158° and 176° F. For loose wool it is better not to exceed 185° F., keeping the temperature from half to three-quarters of an hour between 167° and

185° F. Towards the end of the process of mordanting, the beck, which was at first milky, becomes clear. The goods are lifted and washed very carefully in a strong flow of water.

For dyeing, make up 875 to 1,000 gallons water at 122° F., with $24\frac{1}{4}$ ozs. methyl green in powder, picric acid as required, and $8\frac{3}{4}$ lbs. acetate of zinc. If the green does not work on properly, add a little acetate of soda, not, however, exceeding 25 ozs., and if, on the other hand, the picric acid does not work on, add a little more of the acetate of zinc. No trace of copper or lead must be present. The dye-beck should be of wood, and the steam-pipes of tin.

Reddish Grey on Yarns (55 lbs.).

Boil for an hour with $6\frac{1}{2}$ lbs. fustic, $5\frac{1}{2}$ lbs. catechu, $4\frac{1}{2}$ ozs. chromate of potash, and 13 ozs. copperas.

Grey Mode (110 lbs.).

Boil for an hour with $4\frac{1}{4}$ ozs. alum, $5\frac{1}{2}$ lbs. sulphate of soda, 17 ozs. oil of vitriol, $1\frac{1}{4}$ oz. extract of indigo, and the same weight of orchil liquor.

Slate Grey (55 lbs.).

Boil the wool or pieces with 11 lbs. logwood, 17 ozs. sulphate of soda, and 8 ozs. sulphuric acid. Lift, and dissolve in the beck 8 ozs. copperas, re-enter, and boil for another half hour. If a very blue tone is required, top with ammonia.

Pearl Grey on Wool and Yarns (218 lbs.).

Give a light blue ground in the vat, and rinse well. Add

to a water 34 ozs. perchloride of tin, boil up, and skim carefully. Add $5\frac{1}{2}$ lbs. chloride of tin and 26 ozs. ammoniacal cochineal, and dye for forty-five minutes at a boil.

Light Grey on Wool (55 lbs.).

Boil for an hour with $8\frac{1}{4}$ ozs. perchloride of tin, 1 lb. 9 ozs. alum, $1\frac{1}{4}$ oz. extract of indigo, and 1 oz. cochineal.

Reddish Grey on Yarn (40 lbs.).

Alum 5 lbs., argol $1\frac{1}{2}$ lb., extract of indigo 10 ozs., fustic 1 lb., and orchil 10 ozs. Boil, cool, enter, and dye at a boil for three-quarters of an hour.

Mode Grey on Yarn (100 lbs.).

Boil for thirty minutes with 25 lbs. alum, and 3 lbs. argol.

Lift, and add to the same beck 10 lbs. extract of indigo, 15 lbs. fustic, and 1 lb. picric acid. Enter at a boil, and work for forty minutes.

Slate Grey on Alpaca (50 lbs.).

Boil with 4 lbs. alum and 2 lbs. argol, and dye with 3 lbs. ground logwood, 4 oz. cudbear, and 2 ozs. extract of indigo.

Greenish Grey on Cloth (10 lbs.).

Boil 6 ozs. galls, $\frac{1}{4}$ lb. fustic, and 1 lb. argol. Cool, enter goods; boil for half an hour, lift, and add 3 ozs. copperas; re-enter, and dye to shade at a boil.

*Reddish Grey on Cloth (10 lbs.)**

Boil 6 ozs. galls, $\frac{1}{4}$ lb. madder, and 1 lb. argol. Cool, enter the cloth; boil for half an hour, lift, and add $\frac{1}{4}$ lb. copperas; re-enter, and dye to shade at a boil.

Lead Colour on Wool (260 lbs.).

Boil for an hour with logwood 22 lbs., sumac 34 ozs., fustic and alum 1 lb. each, argol $\frac{1}{2}$ lb. At the end of this time sprinkle the solution of 2 lbs. 10 ozs. into the beck, and boil for half an hour longer.

Fast Ash Grey on Cloth (70 lbs.).

Give a medium blue in the vat, and enter in a water with $3\frac{1}{4}$ lbs. sumac, the same weight of tartar, $4\frac{1}{4}$ lbs. calliatura wood, $6\frac{1}{2}$ lbs. madder, $3\frac{1}{4}$ lbs. ground fustic, and 1 lb. 10 ozs. ground logwood. Boil the pieces for an hour, and sadden with $8\frac{3}{4}$ ozs. copperas.

Wood Grey (on 132 lbs.).

Boil for an hour with 34 ozs. argol, 13 ozs. madder, $8\frac{3}{4}$ ozs. fustic, 26 ozs. sumac, and $1\frac{1}{2}$ piggins logwood liquor. Sadden with 1 oz. copperas.

Silver Grey on Half-Woolen Cloth (20 lbs.).

Dissolve 2 ozs. tannin in a hot water, and turn for an hour. Sadden in a fresh water with 1 lb. nitrate of iron to shade.

Fast Pearl Grey (120 lbs.).

Dye a light blue in the vat, rinse, and make up a boil-

ing water with 3 lbs. alum, 3 lbs. tartar, $2\frac{1}{2}$ lbs. cochineal, and 1 lb. sulphate of tin. Enter, and boil for twenty-five minutes.

Wood Colour on Half-Woolens (4 lbs. 6 ozs.).

Sulphate of soda 2 lbs. 3 ozs., sulphate of alumina 4 lbs. 6 ozs., orchil 2 piggins, turmeric 11 lbs.

Dye, wash, and pass into a water, to which have been added bichromate of potash, turmeric, and redwood.

Blue Lavender on Yarns (110 lbs.).

Boil for an hour with 2 lbs. 3 ozs. logwood, $4\frac{1}{2}$ ozs. extract of indigo, 1 lb. orchil, $\frac{1}{2}$ lb. each alum and copperas.

Lavender on Wool (100 lbs.).

Boil out 5 lbs. logwood, 3 lbs. orchil, and $\frac{1}{2}$ lb. camwood; enter the goods, boil for one hour and a quarter, and sadden with 10 ozs. copperas.

"Modes" on Alpaca (100 lbs.).

(The term "modes," often met with in French and German receipts for dyeing, has no exact equivalent in English. It includes a number of very impure colours, which are neither brown, grey, drab, nor olive, but incline sometimes to one and sometimes to another.)

Shade 1:—

Boil with 2 lbs. argol, 3 lbs. madder, $\frac{3}{4}$ lb. fustic, $\frac{1}{4}$ lb. ground logwood, $\frac{1}{2}$ lb. galls, $\frac{1}{2}$ lb. cudbear, and 2 ozs. extract of indigo. Sadden with $\frac{1}{4}$ lb. copperas.

Shade 2:—

2 lbs. argol, 5 lbs. madder, $1\frac{1}{2}$ lb. ground fustic, $\frac{1}{2}$ lb.

galls, $\frac{1}{2}$ lb. cudbear, and 1 lb. ground logwood. Sadden with 1 oz. copperas.

. *Shade 3:—*

Boil with $1\frac{1}{2}$ lb. bichromate potash and 1 lb. argol.

Dye with 12 ozs. ground logwood, 1 lb. ground fustic, 8 lbs. madder, and 4 ozs. galls. Sadden with 1 oz. copperas.

Shade 4:—

Boil with 8 lbs. madder, 3 lbs. calliatura wood, 1 oz. galls, 1 lb. argol, and 20 ozs. ground fustic. Sadden with 2 ozs. copperas and 4 ozs. cudbear.

Shade 5:—

1 lb. argol, 4 lbs. madder, $1\frac{1}{4}$ lb. ground fustic, 1 oz galls, and 8 ozs. cudbear. Sadden with $1\frac{1}{2}$ ozs. copperas.

Shade 6:—

Boil with 4 lbs. alum and 1 lb. argol, and dye with $2\frac{1}{2}$ lbs. ground fustic and 4 ozs. madder. Sadden with 1 oz. copperas.

Medium Blue Mode on Half-Woollens (100 lbs.).

The wool is first dyed with—

Nicholson blue	.	.	.	.	.	$\frac{7}{10}$ lb.
Soda	.	.	.	.	.	$1\frac{1}{2}$ lb.

at a boiling heat for an hour, and raised in a fresh, hot water, with the necessary quantity of sulphuric acid.

The goods are then steeped over-night in the hot solution of tannin $1\frac{1}{2}$ lb. and hæmatine $\frac{3}{4}$ lb. They are then taken through a cold black liquor at $2\frac{1}{2}^{\circ}$ Tw., rinsed, taken again through the tannin bath, and rinsed.

Instead of hæmatine, decoction of logwood may be used, and the goods may be topped with extract of indigo,

methyl blue, or methyl violet, according to the shade required.

Yellowish Mode for Mixed Goods (10 lbs.).

Boil 1 lb. good catechu in water; let settle, and dissolve $1\frac{1}{2}$ ozs. blue-stone in the clear solution. Raise to a boil, and work the goods first at that heat, and afterwards at 122° F. Lift, drain, and make up a cold water with $\frac{1}{2}$ lb. nitrate of iron. Work for an hour, drain in the centrifugal, and make up a fresh boiling water with $1\frac{1}{2}$ oz. chromate of potash. Work for a quarter of an hour, rinse, and dry. For yellower tones, a little fustic and alum may be added; and for redder tones, peachwood and magenta.

Mulberry on Wool (11 lbs.).

Boil for an hour and a half with $2\frac{3}{4}$ ozs. chromate of potash, 7 ozs. alum, $1\frac{3}{4}$ oz. blue-stone, and $5\frac{1}{2}$ ozs. prepared tartar. Let cool in the flot, or rinse at once. Then dye in a water with 30 ozs. logwood, $5\frac{1}{2}$ lbs. camwood, and 1 lb. cudbear, boiling for seventy-five minutes.

Mulberry on Cloth (84 lbs.).

Boil with $1\frac{1}{2}$ lb. bichromate of potash, and dye in a fresh water with 10 lbs. camwood, 10 lbs. logwood, and 10 lbs. cudbear, boiling for half an hour, and adding 1 quart ammonia.

Greenish Mode on Yarns (55 lbs.).

Boil for an hour with 13 ozs. chromate of potash and the same weight of argol. Let cool in the liquid, and dye in a fresh water at a boil for one hour, with 2 lbs. 3 ozs. fustic, 9 ozs. sanders, and the same weight of sumac.

Greenish Olive on Yarns (55 lbs.).

Prepare as in the last receipt, and dye with catechu 2 lbs. 3 ozs., fustic $6\frac{1}{2}$ lbs., and logwood 17 ozs.

Another Olive on Yarns (55 lbs.).

Prepare as above, and dye with 2 lbs. 3 ozs. logwood, 17 ozs. fustic, and the same weight each of sumac and sanders.

Golden Olive on Wool (219 lbs.).

Boil for an hour and a half with $6\frac{1}{2}$ lbs. chromate of potash, $3\frac{1}{4}$ lbs. blue-stone, and 1 lb. 10 ozs. oil of vitriol.

Dye with 12 lbs. French extract of fustic, 17 ozs. French extract of logwood, $6\frac{1}{2}$ lbs. sanders, and the same weight of madder. Boil for an hour and a quarter, sadden with 26 ozs. copperas, and boil for half an hour longer.

Golden Olive on Cloth (110 lbs.).

Boil together the decoction of 88 lbs. fustic, 22 lbs. turmeric, $2\frac{3}{4}$ lbs. orchil, 11 lbs. alum, and 4 lbs. 6 ozs. argol. Cool, enter, and boil for an hour.

Light Olive on Wool (50 lbs.).

Boil for an hour and a half with $\frac{1}{2}$ lb. chromate of potash, $\frac{1}{2}$ lb. argol, and $\frac{1}{4}$ lb. alum. Dye in a fresh water with $\frac{1}{4}$ lb. logwood, 1 lb. fustic, and $\frac{1}{4}$ lb. camwood.

Olives on Carpet Yarn (100 lbs.).

Dye in a water slightly soured with oil of vitriol, at 160° F., with 1 lb. Olive No. 1 (Clayton Aniline Company,

Manchester). Raise to a boil, work for thirty minutes, and wash. Use the "olive" in two halves—one to begin with, and the other in about fifteen minutes.

Olives No. 2 and No. 3, used in the same manner, give different shades.

Olive on Woollen Reys (10 lbs.).

Boil for forty-five minutes with alum $5\frac{1}{4}$ ozs., oil of vitriol $4\frac{3}{4}$ ozs.

Lift, and add to the same bath—

Picric acid $6\frac{1}{2}$ ozs.

Extract of indigo 6 to $6\frac{1}{4}$ ozs.

Boil for forty-five minutes, lift, and add orchil 14 to $15\frac{1}{2}$ ozs. Boil till even, and wash.

Bronze Olive on Cloth (50 lbs.).

Boil for two hours with fustic 38 lbs., logwood 3 lbs., calliatura wood $\frac{1}{2}$ lb., sumac 3 lbs., argol 2 lbs. Sadden with blue-stone 2 lbs. Boil for an hour, and then add copperas 2 lbs., and boil for an hour longer.

New Orange (100 lbs. yarn).

Dissolve in a water 10 lbs. sulphate of soda, $1\frac{1}{2}$ lbs. of the "New Atlas Orange" (Brooke, Simpson, and Spiller), and 2 lbs. oil of vitriol. Enter at 180° F., raise to 212° F., and boil for fifteen minutes.

Orange (50 lbs. yarn).

Make up a water at 170° F. with 8 ozs. "orange" (Bind-schedler, Busch and Co.). Add $1\frac{1}{2}$ lb. oil of vitriol. Give

three to five turns, rising to a boil, and boil for ten minutes.

Orange (110 lbs. cloth).

Boil up in a water 26 ozs. perchloride of tin; add 5 lbs. oxalic acid, $3\frac{1}{4}$ lbs. tin crystals, 17 ozs. flavine, and from 7 to 17 ozs. cochineal. Cool, enter the cloth, and boil for three-quarters of an hour.

Aurantine Orange on Yarn (100 lbs.).

Add to a water 1 lb. aurantine, 2 lbs. tartar, 3 lbs. cochineal, $\frac{1}{2}$ lb. tin crystals, 8 lbs. muriate of tin, and 5 lbs. muriatic acid.

Boil ten minutes before entering the yarn; cool, enter, turn for ten minutes, and boil for half an hour. Rinse and dry.

Orange on Worsted (50 lbs.).

Prepare bath with $2\frac{1}{4}$ lbs. oil of vitriol and $\frac{1}{2}$ lb. fast orange (Reid, Halliday, and Sons, Huddersfield). Enter at 180° F., raise to a boil, turn to shade, and wash.

Light Orange on Cloth (84 lbs.).

Boil up in a water 8 lbs. fustic, add 20 ozs. ground cochineal, 1 gallon nitrate of tin, and 4 lbs. tartar crystals. Boil for three minutes, and enter.

Orange on Half-Woollens (4 lbs. 6 ozs.).

Dye in one bath. Dissolve annatto, $6\frac{1}{2}$ lbs., in carbonate of soda, 4 lbs. 6 ozs. Dissolve at a boil, and add turmeric according to the shade. Enter in the dye-bek cold, and raise the heat till the shade is obtained. Wash.

Scarlet (50 lbs. yarn).

Make up a water with 5 lbs. sulphate of soda, 1 lb. oil of vitriol, and 10 ozs. ponceau 3 R. C. (of A. Poirrier, of Paris).

Enter yarn at 180°, give three turns, raise to a boil, which is kept up for fifteen minutes; lift, wash, and dry.

Scarlet (50 lbs. yarn).

Make up water at 170° F., with 8 ozs. "scarlet R. R." (Bindschedler, Busch, and Co., of Bâle), and 1½ lbs. oil of vitriol.

Enter, give three to five turns whilst raising to a boil; boil for ten minutes, wash, and dry.

New Atlas Scarlet (100 lbs. yarn).

Dissolve in a water 1½ lbs. New Atlas Scarlet No. 1 (Brooke, Simpson, and Spiller), 10 lbs. sulphate of soda, and 2 lbs. oil of vitriol. Enter at 180° F., raise to 212° F., and boil for a quarter of an hour.

Crimson on Cloth (20 lbs.).

Dissolve 1¾ oz. magenta crystals in 1 lb. glycerine at a boil, filter, and add the solution to a water in which ½ lb. picric acid and ¼ lb. carbonate of soda crystals are dissolved. Boil the bath for a quarter of an hour, and skim off any impurities which rise to the surface.

Enter the cloth and dye to shade at a boil. Drain, but do not rinse.

Cochineal Pink (30 lbs.).

Make up a water with 1 pint tin solution, and ¾ lb. of

tartaric acid; let it boil, skim, add $\frac{1}{4}$ lb. cochineal, let cool a little, enter the wool, and boil for half an hour.

The tin solution is made by dissolving 5 lbs. tin in a mixture of 10 lbs. muriatic and 10 lbs. nitric acids.

Fast Cochineal Crimson on Wool (10 lbs.).

Boil a water for ten minutes with $\frac{1}{2}$ lb. tartar crystals, and skim if needed. Add 1 lb. alum and $\frac{3}{4}$ lb. tin solution. Boil the wool in this mordant for half an hour, and then dye with $1\frac{1}{4}$ lb. ammoniacal cochineal paste and a small quantity of tin solution.

Fast Alizarine Red on Yarn (22 lbs.).

Boil for one hour and a half with $3\frac{1}{4}$ lbs. sulphate of alumina, and 17 ozs. tartar. Rinse well, and dye with 14 ozs. alizarine paste at 10 per cent., entering the goods in the cold beck, and raising to a boil.

If the spent beck is mixed with 17 ozs. sulphate of alumina, the same weight bisulphate of soda, a little fustic and indigo-extract residues, it produces a fine brown.

Another Alizarine Red.

Put the wool or woollen goods in a solution of 34 ozs. soap, in 22 lbs. water at 110° F., for twenty minutes. Press between cloths, dry in hot air, take through red liquor at 5° Tw., to which has been added a solution of 1 oz. sulphomuriate of tin per pint, and dry in hot air. Take through a solution of 60 grains silicate of soda at 92° Tw. for 35 fluid ozs. Heat to 110° F., wash, and drain in the centrifugal.

Dye with alizarine for reds, using for 35 ozs. wool, 7 ozs. alizarine at 10° F.

Rose on Wool, for Fulling (110 lbs.).

Boil up 13 lbs. 2 ozs. alum, $5\frac{1}{2}$ lbs. argol, $8\frac{3}{4}$ ozs. perchloride of tin, the same weight of tin crystals, and 2 lbs. 3 ozs. cochineal. Cool, enter the wool, and dye for an hour.

Crimson on Yarn, for Fulling (55 lbs.).

Make up a water with $8\frac{3}{4}$ ozs. perchloride of tin, and an equal weight of oil of vitriol. Add a clear solution of magenta as required. Enter yarns, dye at a boil, rinse, and dry.

Full Red on Yarn, for Fulling (74 lbs.).

Boil up a water with 34 ozs. perchloride of tin, add to the beek $4\frac{1}{4}$ lbs. oxalic acid, $2\frac{1}{4}$ lbs. tin crystals, $10\frac{1}{2}$ ozs. flavine, and 20 ozs. cochineal. Cool, enter the yarn, and dye at a boil for half an hour. Add 4 lbs. 6 ozs. alum, and boil for fifteen minutes longer.

Aurantine Ponceau (80 lbs.).

Boil up 2 ozs. aurantine, 6 ozs. tin crystals, 10 lbs. cochineal, 2 lbs. tartar, $\frac{1}{2}$ lb. tin crystals.

Boil ten minutes, cool, enter yarn, turn ten minutes, boil for half an hour, rinse, and dry.

Aurantine Scarlet (80 lbs.).

Add to a water 8 lbs. cochineal, 2 lbs. tartar, 8 lbs. muriate of tin, 6 ozs. tin crystals, and 2 ozs. aurantine.

Work as in the last receipt.

Crimson on Alpaca (100 lbs.).

Prepare at a boil with 4 lbs. alum and $\frac{1}{4}$ lb. tartar, and dye with 10 ozs. best magenta.

Magenta on Shoddy (100 lbs.).

Boil with 8 lbs. alum and 1 lb. argol, and dye with 10 ozs. magenta.

Rouge de Gravelotte.

A cochineal red, grounded as usual with cochineal, oxalic acid, and tin crystals, and topped in a fresh water with magenta, or preferably with saffranine.

Ponceau on Cloth (100 lbs.).

Clear the water at a boil with $\frac{1}{2}$ lb. perchloride of tin, boil $2\frac{1}{2}$ lbs. bark, tied up in a bag, for fifteen minutes. Take out the bag, and add 4 lbs. oxalic acid, 3 lbs. tin crystals, 1 lb. tartaric acid, 1 lb. tartar crystals, and $6\frac{1}{2}$ to 7 lbs. ground cochineal. Boil up, cool, and enter the goods previously wetted.

Red for Woollen Yarns, for Fulling (100 lbs.).

Boil with 8 lbs. cochineal, 8 lbs. tartar crystals, 4 lbs. oxalic acid, 4 lbs. tin crystals, 6 lbs. tin solution, and 6 lbs. young fustic lake.

The tin solution is made by dissolving 10 lbs. tin crystals and 25 lbs. bichloride of tin in $8\frac{1}{2}$ gallons hot water.

Fiery Madder-Red on Wool, to bear Fulling (100 lbs.).

Boil for an hour with 12 lbs. alum, 10 lbs. tartar, 2 lbs. oxalic acid.

Rinse, and dye with 50 lbs. madder, boiling slowly for one hour and a half to two hours.

The colour is faster if 25 lbs. alum are taken, 13 lbs. garancine may be used instead of the madder, or about 5 lbs. alizarine for red.

Rose and Crimson on Woollen Yarns.

Dissolve 2 parts magenta, 2 parts silicate of soda, 1 part sulphate of soda, and (for the crimson) a little picric acid. Work the yarn at 167° F. The magenta must be well dissolved and strained to prevent spotting. After dyeing, work the yarns for a quarter of an hour in a fresh cold water with 2 parts hyposulphite of soda.

Sang de Bœuf on Yarns (11 lbs.).

Boil for three-quarters of an hour with $2\frac{1}{4}$ ozs. chromate of potash, $\frac{1}{2}$ oz. blue-stone, 13 ozs. argol, 1 oz. sulphuric acid.

Let the yarn cool in the bath, and then dye in a fresh water with $4\frac{1}{4}$ lb. peachwood and $4\frac{1}{4}$ to $5\frac{1}{4}$ ozs. logwood. Boil for half an hour.

Darker Sang de Bœuf on Yarns (11 lbs.).

Prepare at a boil with $4\frac{1}{2}$ ozs. chromate of potash, $1\frac{1}{8}$ oz. blue-stone, 13 ozs. argol, $1\frac{1}{8}$ oz. oil of vitriol.

Let cool in the liquid, and dye for half an hour at a boil with $4\frac{1}{4}$ lbs. peachwood, $\frac{1}{2}$ lb. fustic, and 1 lb. logwood. The woods are used in the form of clear decoctions, added by degrees.

Scarlet on Worsted (50 lbs.).

Dissolve $3\frac{1}{2}$ ozs. scarlet XXB, and 2 ozs. orange (both of Banning, Bissell and Co., New York), 8 lbs. sulphate of soda, $1\frac{1}{2}$ lb. oil of vitriol, $\frac{1}{2}$ lb. alum. Cool, enter at 180° F., raise to a boil, and turn to shade.

Garnet on Floss Worsted (60 lbs.).

Boil 6 lbs. sulphate of soda, 2 lbs. alum, 3 lbs. sulphuric

acid, 6 ozs. orange A, $\frac{1}{2}$ lb. maroon S, 2 ozs. magenta S (all three of the Baden Aniline Co.). Cool, enter yarn, and boil to shade. After boiling half an hour, add $\frac{1}{2}$ lb. extract of indigo.

Crimson on Carpet Yarn (100 lbs.).

Dissolve 10 lbs. sulphate of soda, 2 lbs. alum, 3 lbs. oil of vitriol, $\frac{1}{2}$ lb. scarlet, and 3 ozs. magenta (both of Levinstein and Co., Manchester). Enter at 180° F., ten turns whilst raising to 212° F., and turn to shade.

Ruby (100 lbs. yarn).

Dissolve 1 $\frac{1}{2}$ lb. orselline (Clayton Aniline Co., Manchester). Enter at 160° F. and raise to a boil, turning to shade. The addition of alum brightens.

Garnet on Worsted Yarn (50 lbs.).

Boil 5 lbs. sulphate of soda, 3 lbs. oil of vitriol, 10 ozs. nazarat, and 3 ozs. orange (both of the Berlin Aktien Gesellschaft), and $\frac{1}{2}$ lb. extract of indigo. Enter, boil for three-quarters of an hour, turning to shade.

Scarlet on Worsted (50 lbs.).

Dissolve 3 lbs. alum, 3 lbs. sulphate of soda, 2 $\frac{1}{2}$ lbs. oil of vitriol, 1 lb. fast scarlet R (Reid, Halliday, and Sons, Huddersfield). Enter at 180° F., five turns, raise to a boil, and turn to shade. Wash.

Rose Bengale on Woollen Yarn (50 lbs.).

Dissolve in a water 4 lbs. alum and 3 ozs. "rose Bengale

B" (Farbwerke, Hoechst am Main). Enter yarn at 180° F., and turn to shade, raising temperature to a boil.

Fast Cardinal on Wool (100 lbs.).

Dissolve $1\frac{1}{4}$ lb. orange 23, and 5 ozs. acid magenta (Bredt and Co., New York), along with 13 lbs. sulphate of soda and 2 quarts oil of vitriol. Enter, and boil to shade.

Phloxine on Woollen Yarn (50 lbs.).

Dissolve in a hot water $\frac{1}{2}$ lb. phloxine BB (P. Monnet and Co., Geneva). Enter yarn at 180° F., five turns while raising to a boil. Lift, and add $\frac{1}{2}$ lb. acetic acid. Re-enter, give four turns.

Eosine on Woollen Yarn (50 lbs.).

Dissolve 6 ozs. eosine (P. Monnet and Co.), enter yarn, and work in the same manner as phloxine.

The "Eosine J" of the same firm is dyed as follows (100 lbs.):—

Dissolve 20 ozs. eosine J, and add the half of it and 1 pint acetic acid to a water at 120° F. Enter yarn, work for half an hour; lift, and add the remainder of the colour to the acid. Re-enter yarn, work for another half hour, raising the heat to 180° F. Wash, and dry.

The "Rose Bengale NT" of the same firm is also dyed in the same manner.

Flesh Colour on Worsted (50 lbs.).

Clear the water well, if needful, by boiling it up with a little sulphate of soda and sulphuric acid. After skimming add 5 lbs. sulphate of soda and 1 lb. oil of vitriol with $\frac{3}{4}$ oz. scarlet RRR (Farbwerke, Hoechst am Main).

Enter at 150° F., turn well, heating to 180° F., and work to shade.

Fast Bluish Cardinal on Wool (50 lbs.).

Boil up 6 ozs. magenta S, and 1 oz. orange A (both of the Baden Aniline Co.), 10 lbs. sulphate of soda, 5 lbs. alum, and add 3 lbs. oil of vitriol. Cool, enter yarn at 150° F., turn till level, raise to a boil, which is kept up for one hour.

Rocceline Scarlet (11 lbs.).

Boil for an hour and a half with $\frac{3}{4}$ oz. stannate of soda, and the same weight each of tartaric acid and oxalate of potash. Lift, and dye in a fresh water, boiling for one hour with $3\frac{1}{8}$ ozs. rocceline and $\frac{3}{4}$ oz. saffranine of a yellowish tone. Let the wool cool in the liquor, lift, and rinse. Darker shades may be obtained in a similar manner by preparing the same quantity of wool with $1\frac{1}{4}$ oz. oxalate of potash and $\frac{3}{8}$ oz. alum.

Fast Red on Cloth (60 lbs.).

Prepare a clean water at a boil, and add $\frac{1}{2}$ lb. alum, $\frac{1}{4}$ lb. solid chloride of tin, and 1 lb. powdered starch. Skim carefully and take the cloth through slightly to damp the same. Add to the bath 8 lbs. alum, 2 lbs. tartar emetic, $\frac{3}{4}$ pint acetic acid, the solution of 2 ozs. aniline orange. When well mixed, enter and raise to boiling point in half an hour. Let cool down to 170° F., and add, in three doses, the solution of 6 ozs. eosine B; gradually increase the temperature again while turning the cloth, and shade off with 2 ozs. aniline orange, and $\frac{3}{4}$ pint acetic acid.

This red may be dyed in copper vessels, and is only half the price of a cochineal red. It may be dyed over black checks without interfering with the black.

Another Fast Red on Cloth (24 lbs.).

Boil in a water containing 4 lbs. alum, 12 lbs. madder, $4\frac{1}{2}$ lbs. tartar crystals, and 3 lbs. nitrate of tin. Let lie twenty-four hours and pass into a water with 5 lbs. cochineal, $\frac{1}{2}$ lb. tartar, and boil for an hour. Add 5 lbs. lac-dye and 2 lbs. nitrate of tin; boil for an hour and pass into a bath of 3 lbs. madder and 2 lbs. nitrate of tin.

New Scarlet on Wool (60 lbs.).

Yarn well scoured, washed in warm water, and whizzed. Run beck three-quarters full of water and boil. Put in 10 ozs. "scarlet OO" (A. Poirrier, of Paris, and Thompson, of Manchester). Boil well, and add 9 lbs. sulphate of soda and 1 quart oil of vitriol. Fill up with cold water, stir well, and enter yarn. Keep turning for fifteen to twenty minutes, and heat gradually to a boil in seventy-five minutes. This is a very fast scarlet.

Garnet on Half-Woollens.

Boil for half an hour with a water containing $6\frac{1}{4}$ ozs. bichromate of potash, $4\frac{1}{4}$ ozs. oil of vitriol, and 2 ozs. blue-stone. Rinse, and enter in a water at 122° F., containing magenta $1\frac{3}{8}$ oz., and methyl violet $\frac{1}{4}$ oz. Heat to a boil, lift, wash, and rinse.

Claret on Half-Woollens.

Boil for half an hour with bichromate of potash $6\frac{1}{4}$ ozs., oil of vitriol $4\frac{1}{4}$ ozs., and blue-stone 2 ozs. Rinse, and dye with magenta $1\frac{3}{8}$ oz., aniline scarlet $1\frac{3}{8}$ oz., orchil $6\frac{3}{4}$ lbs., and turmeric 12 ozs. Enter cold, raise slowly to a boil, and after boiling for an hour and a half, lift, and wash.

Corinthe on Damask (20 yards).

Boil for half an hour with alum 17 ozs., argol 17 ozs. Then add orchil 2 lbs. 2 ozs., extract of indigo $8\frac{1}{2}$ ozs., oil of vitriol $\frac{1}{2}$ oz. Dye to shade at a boil. Lift, and rinse.

Dark Garnet on Half-Woolens (22 lbs.).

Dye the wool to shade in a boiling water with orchil, a little extract of indigo, and prepared tartar. Steep over-night at a hand-heat with

Catechu	.	.	.	.	2 lbs. 3 ozs.
Blue-stone	.	.	.	.	7 ozs.

Sadden at a hand-heat with

Chromate of potash	.	.	.	.	$3\frac{1}{2}$ ozs.
Copperas	.	.	.	.	$1\frac{3}{4}$ „

Steep over-night in the cold solution of 2 lbs. 3 ozs. alum, and dye the cotton to shade in the cold, with the decoctions of peachwood, fustic, and logwood.

Red on Half-Woolens (11 lbs.).

Boil for an hour with 17 ozs. white argol and the same weight of argol. Dye at a boil for fifteen minutes with 4 lbs. 14 ozs. peachwood and $2\frac{1}{4}$ lbs. fustic.

Rinse, steep for fifteen minutes in the decoction of 2 lbs. 3 ozs. fustic, and work for the same length of time in red cotton spirits at 4° Tw. Let drain, and cotton-dye to shade in the cold decoction of 17 ozs. peachwood and the same weight of fustic.

Reseda on Yarns (55 lbs.).

Boil for an hour and a half with 13 ozs. each chromate

of potash and argol. Let cool in the liquor, and dye at a boil for an hour with $\frac{1}{2}$ lb. fustic and 1 lb. logwood.

Darker Shade of Reseda (55 lbs.).

Prepare as above, and dye with 8 ozs. logwood, 1 lb. extract of indigo, and $4\frac{1}{2}$ ozs. orchil.

Light Reseda on Yarn (100 lbs.).

Boil 10 lbs. alum, 3 lbs. argol, 2 ozs. oil of vitriol, 5 ozs. extract of indigo, 7 ozs. orchil paste, and $2\frac{1}{2}$ ozs. picric acid, or, in place of the latter, 2 lbs. fustic. Boil up cool, enter the goods, and boil for forty-five minutes.

Reseda on Wool (50 lbs.).

Boil for seventy-five minutes with $\frac{1}{2}$ lb. chromate of potash $\frac{1}{2}$ lb. argol, $\frac{1}{4}$ lb. alum.

Dye in a fresh water with $\frac{1}{4}$ lb. logwood, 1 lb. fustic, and $\frac{1}{4}$ lb. camwood.

Light Salmon on Yarn (100 lbs.).

Oxalic acid 7 lbs., tin crystals 2 lbs., cochineal 12 ozs., and flavine 3 ozs. Boil, cool, enter and boil for three-quarters of an hour. By adding more flavine the shade may be turned to an orange, and to a red by more cochineal.

Slate on Wool (100 lbs.).

Boil 4 lbs. logwood.

„ 2 ozs. camwood.

„ 1 lb. fustic.

„ 2 ozs. madder.

„ 2 ozs. sumac.

„ 2 ozs. indigo extract.

Boil fifteen minutes, cool, enter, and work well, boiling for an hour. Sadden with $\frac{1}{4}$ lb. copperas and $\frac{1}{2}$ lb. argol, and boil twenty minutes longer.

Lighter Shade of Slate (100 lbs.).

Boil for fifteen minutes—

- 2 lbs. logwood.
- 4 ozs. camwood.
- 12 ozs. fustic.
- 4 ozs. madder.
- 4 ozs. sumac.
- 2 ozs. extract of indigo.

Cool, enter, work well, and boil for one hour. Sadden as above, and boil for twenty minutes longer.

Stone Colour, Dark, on Wool (220 lbs.).

Boil with $6\frac{1}{2}$ lbs. each fustic and madder, 13 lbs. sumac, and $2\frac{3}{4}$ lbs. argol, for an hour and a half; sadden with 34 ozs. copperas, and boil for three-quarters of an hour longer.

Stone Colour, Light (220 lbs.).

Boil for an hour with $6\frac{1}{2}$ lbs. alum, half that weight of argol, $14\frac{1}{4}$ lbs. ground logwood, $13\frac{1}{4}$ lbs. sumac, $3\frac{1}{4}$ lbs. ground fustic, and $6\frac{1}{2}$ lbs. madder. Sadden with 19 ozs. copperas, boiling for half an hour longer.

Violet on Wool (55 lbs.).

Dissolve $4\frac{1}{2}$ ozs. methyl violet of a suitable shade in water. Add the solution to the beck, in which 2 lbs. 3 ozs. of sulphate of soda are also dissolved. Boil up, cool, enter the wool, and dye at a brisk boil.

Pansy on Yarn, for Fulling (54 lbs.).

Make up a water with $\frac{1}{2}$ lb. perchloride of tin and the same weight of sulphuric acid. Add a clear solution of methyl violet as required. Enter, dye at a boil, rinse, and dry.

Bluish Pansy on Alpaca (100 lbs.).

Prepare at a boil with 8 lbs. alum, 3 lbs. chloride of tin, 2 lbs. oil of vitriol, and 2 ozs. aniline blue of a reddish shade, and then top with 8 ozs. reddish aniline blue and 2 ozs. magenta.

Pansy on Cloth (100 lbs.).

Give a light blue ground in the vat, rinse, and boil for ninety minutes with 10 lbs. alum, 4 lbs. argol, $\frac{1}{2}$ lb. tin crystals, and 1 lb. oil of vitriol.

Top at a boil in a fresh water with 20 lbs. logwood, 5 lbs. redwood, and the solution of 3 to 6 lbs. aniline violet.

Pansy for Vicuna (10 lbs.).

Enter the clean yarn in a boiling water with 1 lb. tannin, and steep for four to five hours. Wring, and steep for two hours in bichloride of tin at $2\frac{1}{2}^{\circ}$ Tw. Rinse, wring, and dye to shade in methyl violet BBBB at a hand-heat.

Gentiana Violet on Wool (11 lbs.).

Dissolve in a water 7 ozs. argol and the necessary amount of colour, previously dissolved; boil, and skim. The goods are entered, and after three turns the shade is level.

The colour is dissolved in water at 140° F., and quickly raised to a boil, which is kept up for five minutes. The

solution is then strained. One pound of colour requires 30 lbs. (3 gallons) of water.

Violet 2 B on Worsted Yarn (50 lbs.).

Dissolve 4 ozs. violet 2 B (Bindschedler and Busch) in water at 180° F.

Enter, give four to six turns whilst raising to 212° F., and boil to shade.

Purple on Woollen Yarn (50 lbs.).

Dissolve 5 lbs. sulphate of soda and 5 ozs. Violet de Paris 350 NB (A. Poirrier, of Paris). Cool down to 150° F., enter quickly, bring to a boil, and turn to shade.

Violet on Woollen Yarn (50 lbs.).

Dissolve in water 5 ozs. violet No. 28 (Reid, Halliday, and Sons, Huddersfield).

Enter yarn at 150° F., turn briskly whilst raising to a boil. Let cool, and wash.

Violet on Yarn (50 lbs.).

Dissolve 5 lbs. sulphate of soda, 7 ozs. "acid violet" (Farbwerke, Hoechst am Main), and 1 lb. oil of vitriol. Enter at 150° F., turn briskly, raise to a boil, and work for three-quarters of an hour.

Violets on Woollen Yarn (100 lbs.).

The violets "5 B," "3 B," and "R R," of Monnet and Co., of Geneva, are dyed by simply dissolving in water at 180° F., entering, giving six or eight turns whilst raising

water to a boil, and boiling to shade. Half a pound of each of the above colours gives a full shade.

Alkali Violet on Wool (30 lbs. yarn.).

Dissolve $\frac{1}{2}$ lb. borax and 5 ozs. "alkali violet" (Farbwerke, Hoechst am Main).

Enter at 140° F., give four turns rapidly, raise to a boil, lift when dark enough, wash, and raise in a fresh lukewarm water with $\frac{3}{4}$ lb. oil of vitriol.

The process is the same as for Nicholson blues.

Deep Dahlia on Piece Goods (100 lbs.).

Make up a boiling water with 6 lbs. alum, $1\frac{1}{2}$ lb. bichromate, $\frac{3}{4}$ lb. tin crystals, and 1 lb. oil of vitriol.

Work in this for half an hour, and either wash or leave in the beck. Then dye with 50 lbs. logwood, 10 lbs. calliatura, and 2 lbs. orchil.

Very Deep Violet on Piece Goods (100 lbs.).

Make up a water with $1\frac{1}{2}$ lb. chromate, 3 lbs. alum, $\frac{1}{2}$ lb. tin crystals, $\frac{1}{2}$ lb. sulphuric acid, and $\frac{3}{4}$ lb. oxalic acid. Work in this at a boil, and rinse and let cool in the flot, and then boil for an hour and a half with 40 lbs. logwood, 12 lbs. calliatura, and 2 lbs. orchil.

Fast Lilac on Wool (110 lbs.).

Boil for an hour with 11 lbs. peachwood, $5\frac{1}{2}$ lbs. logwood, 22 lbs. alum, and 11 lbs. argol. Lift, and add 34 ozs. bichloride of tin, and boil for a quarter of an hour longer. To brighten the colour, the solution of $3\frac{1}{2}$ ozs. methyl violet is added.

Light Lilac on Worsted (25 lbs. yarn).

Clear the water, if needful, and add 5 lbs. sulphate of soda, 2 ozs. red argol, 1 lb. sulphuric acid, $\frac{1}{2}$ oz. "violet" (Farbwerke, Hoechst am Main), and $1\frac{1}{2}$ oz. each of indigo extract and orchil extract.

Yellow (50 lbs. yarn).

Dissolve in a water 5 lbs. sulphate of soda crystals and $\frac{1}{4}$ lb. "Jaune S" (A. Poirrier, of Paris). Add 2 lbs. oil of vitriol. Enter at 180° F., and give five turns while raising to 212° F. Boil for five minutes, wash, and dry.

Lemon Yellow on Wool (218 lbs.).

Boil up 83 lbs. fustic, 13 lbs. 2 ozs. alum, the same weight of tartar, and $1\frac{3}{4}$ lb. tin crystals. Skim the beck, enter, and boil for an hour and a half.

Ochre Yellow on Wool (220 lbs.).

Boil with $5\frac{1}{2}$ lbs. chromate of potash and half the weight each of blue-stone and argol, for ninety minutes. Dye in a beck made up of $\frac{1}{2}$ lb. French extract of fustic and $3\frac{1}{4}$ lb. madder, boiling for an hour.

Aurantine Yellow (128 lbs.).

Dissolve 1 lb. aurantine, 8 lbs. alum, 2 lbs. tartar, 8 lbs. muriate of tin, $\frac{1}{2}$ lb. tin crystals.

Boil ten minutes. Cool, enter, turn ten minutes, and boil half an hour. Rinse and dry.

Deep Yellow (100 lbs.).

Dissolve 1 lb. aurantine, 2 lbs. alum, 2 lbs. tartar, 8 lbs. muriate of tin, $\frac{1}{2}$ lb. tin crystals.

Work as above.

Light Yellow (64 lbs.).

Aurantine $\frac{1}{4}$ lb., alum 3 lbs., half-refined tartar 2 lbs., 6 lbs. muriate of tin, 6 ozs. tin crystals.

Work as above.

Yellow on Shoddy (100 lbs.).

Clear the water with perchloride of tin, and boil 50 lbs. bark for half an hour. Add $\frac{1}{2}$ lb. white glue, previously dissolved; boil up, and skim. Dissolve in the clear liquor 3 lbs. oxalic acid, 3 lbs. tin salt, and 1 lb. bichloride of tin. Boil the goods for an hour.

Straw-Colour on Yarn (10 lbs.).

Boil for forty-five minutes with 6 ozs. alum, 3 ozs. argol, $\frac{1}{2}$ lb. fustic, and $\frac{1}{2}$ lb. madder.

Berlin Yellow (50 lbs. yarn).

Dissolve in a water 5 lbs. alum and $\frac{1}{4}$ lb. Berlin yellow (Bindschedler and Busch). Enter at 170° F., give five turns while raising to a boil, and turn to shade.

Fast Yellow (50 lbs.).

Make up a water with 2 $\frac{1}{2}$ lbs. sulphuric acid and $\frac{1}{2}$ lb. fast yellow (Reid, Halliday, and Sons, Huddersfield). Enter at 160° F. Raise to boil, turning to shade, and wash.

Jaune d'Or on Yarn (100 lbs.).

Prepare water at 160° F., with 1 lb. Jaune d'Or (Monnet and Co., Geneva) and 1 lb. acetic acid. Add only half the colour and the acid. Enter yarn, work for thirty minutes, lift, and add remainder of colour and acid. Re-enter, work for thirty minutes more, raising the temperature to 180° F., wash, and dry.

Golden Yellow on Worsted (25 lbs.).

Add to a water $\frac{3}{4}$ lb. oil of vitriol, 3 lbs. sulphate of soda, $\frac{1}{2}$ lb. alum. Boil up, skim carefully if needed, add solution of $\frac{1}{2}$ oz. "golden yellow" (Clayton Aniline Co., Manchester), cool down to 160° F., and enter. Turn briskly, raise temperature, and work to shade.

Dark Golden Carmelite on Worsted (50 lbs.).

Dissolve in a water 5 lbs. sulphate of soda, 1 lb. alum, 1 lb. oil of vitriol, 6 ozs. "dark golden carmelite" (Clayton Aniline Co., Manchester).

Enter yarn at 150° F., raise to a boil, and work to shade.

Naphthal Yellow on Worsted (30 lbs. yarn).

Boil 5 lbs. sulphate of soda, $\frac{1}{2}$ lb. oil of vitriol, $\frac{3}{4}$ oz. naphthal yellow (Baden Aniline Co.). Enter at 160° F., raise to a boil, and turn to shade.

Aventurine on Half-Woollens (4 lbs. 6 ozs.).

Sulphate of soda 2 lbs. 3 ozs., sulphate of alumina 4 lbs. 6 ozs., orchil 1 piggin, turmeric 13 lbs. 2 ozs.

Dye, wash, and then pass into a catechu beck with bi-chromate of potash and turmeric.

SILK DYEING.

Silk occupies, in several respects, an intermediate position between the truly animal and the vegetable fibres. Like wool, it is a highly nitrogenous body, but contains no sulphur. It takes up very many of the colours which can only be worked upon vegetable fibre by the aid of mordants. It tolerates acids better than cotton, but less fully than wool. Like the latter fibre, it is unable to bear the action of strong alkalies, especially at high temperatures. Like cotton, it can be dyed a prussian blue by working alternately in a solution of nitrate of iron and in one of prussiate of potash. It has a strong affinity for iron and for tannin. Cochineal does not work as advantageously upon silk as upon wool, and a true "grain scarlet" upon silk can scarcely be said to exist. On the other hand, carthamine and the aniline colours appear here to the greatest advantage. The great attraction of these colours for silk simplifies silk-dyeing exceedingly. Such colours as aniline orange, cyanosine rose, rose Bengale, phloxine, the various shades of rosine, magenta, the aniline violets, malachite green, the aniline blues, require merely to be dissolved and mixed with perfectly clear water in a clear pan. A little acetic or tartaric acid is often added, and in case of the azo-colours (such as ponceau, grenadine, &c.) a little oil of vitriol.

The sad colours, on the other hand, and especially black, are in many cases extremely complex, the main object of the dyer being not so much to colour the silk as to increase its weight, sometimes to the extent of 400 per cent.

As an example we give a black weighted merely to 200 per cent. :—

Give nine dips in basic sugar of lead at 50° Tw. Wring out and leave covered up for five or six hours, and then pass into cold sulphuric acid at 8° Tw., and wash well. Pass into a 10 per cent. soap-lye at 140° Tw., rinse, and

wring out. Give nine more dips in the basic sugar of lead, leave for six hours, and pass into sulphuric acid as before. Wash well, and pass into logwood liquor with the addition of 5 per cent. of soap, and wash. Steep in black liquor at 40° Tw. for five days, wash and dye in a mixed decoction of logwood and fustic, with the addition of soap. Rinse, and steep in a concentrated decoction of galls for six days, wring, and dye again with decoction of logwood, fustic, and soap. Wash, and soften in an emulsion made with caustic soda at 3° Tw. and olive oil, none of which must float at the top. Finally, dry without washing.

Lions Black.

The silk is first entered in black liquor at 25 or 30 per cent. and washed. Then it is worked in a hot soap-lye, and passed hot into a water containing 22 per cent. of yellow prussiate of potash, and washed. It is then steeped in the black liquor, washed, and soaked for twelve hours in a saturated decoction of catechu, and washed. It is finally dyed in a bath of logwood, containing 25 per cent. of soap.

Bleu de Lyon.

Clear water with sulphuric acid, and give the silks five or six turns. Add the colouring matter to the beck in several successive portions as the dyeing advances. Begin to dye in the cold, and raise gradually to a boil. Soap, rinse, and give a slight brightening in the cold with sulphuric acid.

Soluble Blue.

As Bleu de Lyon, but without soaping.

Aniline Blue with Soap (11 lbs.).

Add to a water at 165° F., 1 lb. 1 oz. sulphuric acid and 3½ ozs. white soap in solution.

Stir up very well and add in four successive portions $1\frac{1}{4}$ oz. blue, previously dissolved in water.

Dye, wash, and rinse with sulphuric acid.

Prussiate Blue (40 lbs.).

Enter in a water (60 gallons) at 120° — 130° F., with 9 lbs. nitrate of iron at 120° Tw., and 1 lb. 10 ozs. tin crystals. Give nine turns, wash, and give nine turns in a warm water with 2 lbs. yellow prussiate and 1 lb. oil of vitriol. Return without washing to the first bath, and give nine turns more. Wash, and give nine more turns in the prussiate bath. Add to the first bath 2 lbs. nitrate of iron and 10 ozs. tin crystals, nine turns and wash. Finally, give nine turns in the prussiate bath, to which 12 ozs. prussiate and 1 lb. sulphuric acid have been added. Wring out, and leave for six hours in a covered bowl. Wash; raise, and dry in the air.

Brown on Silk.

Steep the ungummed silk over-night in alum-water at 100° F. Take out the next morning, and dye in a water with logwood, redwood, and fustic, as the shade requires. For mediums 20 ozs. of each of the three woods suffice for 11 lbs. of silk. The beck is kept at from 167° to 194° F., and the goods are turned from thirty to sixty minutes.

Brown on Mixed Silk and Cotton.

Boil $\frac{1}{4}$ lb. catechu in a water, and make up a beck at 100° F., steep the goods in this for five hours, turning frequently. Lift, wring, and pass into a weak chrome bath at 122° F. Work for half an hour, wash, and dry. If the cotton is too light it may be darkened with a decoction of logwood.

Brown on Silk Waste.

Dye with extract of orchil, nigrosine, turmeric, soap-lye, and sulphuric acid. Enter at 112° F., raise to a boil in three turns, wash well, whiz, and dry.

Chamois on Silk Waste.

Dye with the same wares as yellow at 122°—132° F.

Green on Silk Waste.

Prepare with a solution of silicate of soda at 167° F., using $8\frac{1}{4}$ ozs. silicate of soda to every 2 lbs. 3 ozs. of silk. Drain, and whiz, without ringing. Then boil with $3\frac{1}{2}$ to $5\frac{1}{2}$ ozs. neutral soap.

For methyl-green and iodine-green the silk is steeped with a solution of the colour and a very little soap-lye at 100° F. Raise the heat very gradually to 144° F., wash, and finish in a lukewarm beck with picric acid and very little tartaric acid.

Dark green may be produced with a soluble aniline blue, turmeric, sulphuric acid, and old soap-lye. Enter at 110° F., and raise in three turns to a boil. Wash and finish with acetic and picric acids. It is well to dye the green too much on the blue side, and afterwards dye to shade with picric acid. Turmeric alone gives too flat a shade.

Iron Grey on Silk Thread (11 lbs.).

After boiling, wash well twice, and mordant twice with iron. For light shades take 17 ozs. oil of vitriol and 34 ozs. nitrate of iron, for mediums 4 lbs. 6 ozs. nitrate of iron, and for heavy shades $8\frac{3}{4}$ lbs. Pass the silk through the beck from seven to nine times, and wash twice; dye at

112° F. in a water made up of logwood, redwood, and fustic, and finally finish off in a fresh beck at 122° F. and wash.

Grey (5 lbs. silk).

Add to 2 quarts ammoniacal cochineal at 3° Tw., 1 oz. tartaric and citric acid, $\frac{1}{2}$ oz. extract of indigo, and $\frac{1}{4}$ oz. picric acid. Dissolve well before entering the silk, and dye to shade.

Ponceau on Silk (20 lbs.).

Boil for two hours with 5 lbs. curd soap; enter dye-bath at 120° F., containing enough of the soap-lye to lather freely, along with $\frac{1}{2}$ lb. oil of vitriol and 2 $\frac{1}{2}$ ozs. coccinine (Farbwerke, Hoechst). The colour is dissolved separately and added in three different portions, whilst the heat is raised to a boil, turning to shade. Wash and take through a water with acetic acid.

Magenta.

Clear the dye-bath with tartaric acid. Pour in the solution of the colouring matter, and dye in the cold. If a more violet tone is needed, ground with a Hofmann's violet, according to the shade required, and top with magenta.

Saffranine Rose on Silk.

The silk is prepared as for white, stoved, rinsed, and washed twice in boiling soap-lye. A fresh water at 122° F. is made up with the needful quantity of saffranine, and soured with a fresh solution of tartaric acid. In this the silk is dyed to shade.

Poppy Red.

Make up a cochineal liquor at 4° Tw., and for every

5 lbs. of cochineal thus extracted, use 12 fluid ozs. of the tin spirit given below, and dye. Lift, and leave the silk covered for twelve hours, wash slightly, take through citric acid, and dry.

The tin spirit is made with 4 lbs. muriatic acid, 2 lbs. aquafortis, and $3\frac{1}{4}$ ozs. tin added by degrees.

Another Poppy Red.

Prepare the silk first in a so-called stannate of soda, as given below; take through vitriol sours, wash well, and pass into a solution of red liquor at 8° Tw., thickened with 1 lb. British gum per gallon. Dry and air for twenty-four hours, wash well, dye in decoction of cochineal, and raise with nitrate of tin.

The so-called stannate of soda is made by adding 7 lbs. perchloride of tin to 3 gallons caustic soda at 35° Tw., to which is then added 1 lb. oxalic acid dissolved in 1 gallon of water. Set at 4° Tw., and use it in the cold.

To make the red liquor, dissolve 1 lb. alum in two quarts water. Precipitate the alumina by adding 1 lb. soda crystals dissolved in a quart of water. Collect the precipitate and dissolve it in a quart of strong acetic acid.

Campo-bello Yellow on Silk.

Dissolve in water, enter the silk, and dye to shade at 122° to 140° F.

Yellow on Silk Waste.

Dye at 110° — 132° F. with aniline golden yellow, picric acid, a little aniline orange and tartaric acid.

TISSUE PRINTING.

This branch of the tinctorial art has for its object the production, not of a uniform colour over the entire surface of a piece of cotton, silk, or woollen goods, but of a pattern in two or in many colours. The task of the printer is, therefore, very much more difficult and complicated than that of the dyer. He has not merely to obtain fast, bright, and even colours, but to place them in juxtaposition in such a manner that each shall be strictly confined within given limits without spreading over and soiling its neighbours.

In effecting this object, not merely chemical, but mechanical questions of great nicety have to be taken into consideration. The machines required in a print-works are very numerous, very different in their purposes, and some of them remarkable for the delicacy and complication of their structure. It may be here at once remarked that a useful idea of these machines cannot be conveyed by mere reading. Actual examination, *e.g.*, of a perottine, a cylinder-machine, &c., will give the student in a quarter of an hour a clearer knowledge of these and other mechanical contrivances than he could gain in hours of reading, even with the utmost aid from diagrams. Hence the accounts which will be here given of printing machinery will be very brief.

There is a further distinction between dyeing and printing: the dyer has merely to see to it that each colour which he produces is in itself good of its kind. How the yarns which he dyes may be afterwards arranged by the designer and the weaver, in the production of a pattern in the loom, is outside his knowledge and his responsibility. But in printing, the arrangement of the colours is part and parcel of the business. Colours, in themselves excellent, may be made to look dull, flat, and ordinary, if grouped together in disregard of optical laws. On the other hand,

shades which, taken singly, possess little merit, may, by judicious arrangement, raise and relieve each other, so as to produce a very fine general effect.

Hence tissue-printing stands on the very boundary line between manufactures and the fine arts, and requires the co-operation of the colour-chemist, the mechanician, and the artist. Indeed, the ideal manager of a print-works should combine in himself the knowledge and the resources of all the three.

The first step in preparing goods for printing, is the operation of singeing, already described under bleaching. By this process all loose down is removed from the pieces, so that they may present a perfectly level surface.

Still, however, certain inequalities remain. There are seen, in examining a piece of calico, knots and ends of threads, too thick to be removed by the singeing process without an exposure to the flame sufficient to damage the fabric. Hence "cropping" is necessary. The projections just mentioned are cut off by a specially constructed machine. Bleaching is a necessary preparatory step. As has been already mentioned, goods to be subsequently printed require to be more carefully bleached than if they were to be sent to market in a white state, except when the designs and grounds consist of dark colours.

We may now pass to a description of the so-called "styles," that is, the principles or groups of methods by which designs may be produced upon cloth.

These "styles" employed in calico or other tissue-printing naturally resolve themselves into two main classes. In one of these the entire piece of cloth is submitted to the action of a colouring liquid as in ordinary dyeing. But the action of such liquid is limited by various means to particular parts of the cloth, so that instead of coming out of one uniform shade, it exhibits, when finished, a design in two or more colours. This class includes the so-called madder-, garancine-, reserved-, padding-, indigo-, Turkey-red-, and bronze-styles.

In the second class the colouring matter, mixed up with mordants, is applied to those portions of the cloth only where the design is to appear. The styles belonging to this class are the steam, spirit, pigment, and China-blues. It must be remembered that in actual practice two or more of these styles are often used in combination, and that aniline black forms a style of its own.

The madder-style, so-called because it has principally been used in printing the colours obtained from madder, is also named "dyeing mordants," or more correctly "dyeing upon mordants." The procedure is in substance this:—The mordants, duly *thickened*, and technically known as "*colours*," though containing no colouring matter, are printed on to the calico, being applied merely to the parts where the pattern is to appear. After the printing is effected, the pieces undergo the *ageing* process, for the purpose of enabling the mordants to combine thoroughly and intimately with the fibre. Next follows the operation called *dunging*, the object of which is to remove the thickening which has now played its part and is no longer needed. Then follows the dyeing, which was till lately performed with madder, but is now effected by means of artificial alizarine, and lastly the *clearing* or brightening, the object of which is to remove all colouring matter not perfectly attached to the fibre, and to leave the grounds a pure white.

It must here be remembered that this "style" is not by any means limited to madder and its derivatives. The colouring matter of logwood might, for instance, be applied to cloth in this manner, though in practice this never takes place, as the same effects can be more conveniently produced by other methods.

Madder, or rather alizarine, gives with strong iron-liquor a black; with weaker iron-liquor a violet (technically always spoken of by English printers as *purple*); with red liquor (acetate of alumina), reds, roses, and pinks, according to strength; with a mixture of red-liquor and iron-

liquor, chocolate. Thus by printing on to the cloth two strengths of red-liquor, two strengths of black-liquor, and a mixture of the two, we obtain, on afterwards dyeing the cloth in alizarine, a design of five colours on a white ground.

Madder (*i. e.* alizarine) colours are now often produced by the "steam style," though the shades thus obtained are never quite equal in beauty to such as are dyed on mordants.

The following are some of the most recent processes for madder-work:—

Red on White Grounds, and Red Grounds.

Print on red liquor at 7° to 8° Tw. thickened with flour or gum-substitute, and with the addition of a little tin crystals or oxymuriate of tin.

Age at 86° to 95° F., and dung with dung and chalk. Make up the dye-beck with 1 part "alizarine for reds" at 10 per cent., $\frac{1}{4}$ to $\frac{1}{2}$ "alizarine oil" at 50 per cent., and $\frac{1}{16}$ part acetate of lime, at 21 $\frac{3}{4}$ ° Tw.

Dye for one hour and a half at 158° F. Wash, work in "alizarine oil," taking 1 $\frac{3}{4}$ ozs. to 3 $\frac{1}{2}$ ozs. per 1 $\frac{3}{4}$ pint water, and dry in the hot flue, and steam from three-quarters to one hour and a half. If enough oil has been used in dyeing the second oiling is omitted, and the pieces are dried and steamed at once after dyeing.

Wash and soap three-quarters of an hour at 140°. Repeat soap if needful. If there is no fear of soiling the whites the dyeing for the last half hour may be done at a boil.

If it is desired that the reds, roses, and pinks produced, should verge more to the crimson and less to the scarlet, a little "alizarine for violet" is mixed with the "alizarine for reds" and if a purple is to be produced, the former kind is used alone.

For purples the "colours" printed on are prepared as in the following examples:—

1. *Purple for machine work.*

Black-liquor (iron-liquor), at 24° Tw.	1	gall.
Purple fixing liquor.	2	galls.
Gum water	12	galls.

The "purple fixing liquor" is prepared as follows:—

Water	2	galls.
Soda crystals.	25	lbs.
Arsenious acid	22½	lbs.

Boil till dissolved and add:—

Crude acetic acid at 120° F.	50	galls.
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Let stand for a few days, draw off, clear, and add:—

Muriatic acid at 32° Tw.	3	quarts.
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For the gum-water take:—

Water	1	gall.
Dark calcined farina	6	lbs.

Boil till dissolved.

2. *Padding Purples.*

One part of black-liquor at 25° Tw. is mixed with more or less of the following thickening according to shade:—

Logwood liquor at 8° Tw.	1	quart.
Flour	9	lbs.
Purple fixing liquor	1	gall.
Water	6¾	galls.

Boil, and when dissolved, add:—

Gum-water, as above	1½	gall.
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3. *Alizarine Blacks.*

Since the introduction of aniline blacks, a madder black is seldom required. The following is a specimen of the "colour" to be printed on for their production:—

Crude acetic acid		1 gall.
Black liquor at 24° Tw.		1 gall.
Water		1 gall.
Flour		6 lbs.

The flour is first rubbed up with a little of the mixed liquids to a thin, even paste, and the rest is gradually stirred in. After boiling, add $\frac{1}{2}$ pint olive oil. The subsequent operations for a madder (alizarine) black are similar to those for reds, but in dyeing a larger quantity of colouring matter is needed, which renders these blacks expensive.

Browns.

The "colours" for producing browns in the madder style, contain an admixture of catechu generally accompanied by verdigris (acetate of copper), and sal-ammoniac. The following are examples:—

Brown standard		2 galls.
Acetate of copper		2 quarts.
Acetic acid		1 quart.
Gum Senegal water (1 lb. per quart)		1 quart.

The brown standard above referred to is made with—

Water		12 $\frac{1}{2}$ lbs.
Catechu		50 lbs.

Boil for six hours, and add—

Acetic acid		4 $\frac{1}{2}$ quarts.
Water to make up to		12 $\frac{1}{2}$ galls.

Let settle for forty-eight hours, run off the clear, heat

to 130° F., and add sal-ammoniac 24 lbs. Dissolve, and let stand for forty-eight hours; draw off the clear, and thicken with 4 lbs. gum Senegal per gallon.

The acetate of copper above mentioned is thus prepared—

Blue-stone	16 lbs.
Sugar of lead.	16 lbs.
Boiling water	4 galls.

Dissolve, settle; draw off the clear, and set at 16° Tw.

Brown to resist Heavy Purple "Covers."

Catechu	1 lb.
Sal-ammoniac.	$\frac{1}{2}$ lb.
Lime juice at 8° Tw.	$\frac{1}{2}$ gall.
Nitrate of copper at 80° Tw.	5 ozs.
Acetate of copper as above	3 ozs.
Gum Senegal	2 lbs.

Chocolate.

Black liquor at 24° Tw.	3 quarts.
Red liquor at 18° Tw.	$2\frac{1}{4}$ galls.
Flour	6 lbs.
Oil	5 fl. oz.

An increase in the proportion of red liquor gives chocolates of a more reddish cast, and an increase of black liquor gives a more blue shade.

Drab.

Brown standard, as above	1 gall.
Muriate of iron (protochloride of iron or ferrous chloride) at 9° Tw.	1 quart.
Acetate of copper	3 quarts.
Gum substitute water	1 quart.
(1 lb. per quart.)	

If it is desired that any portion of the design is to remain untouched by the mordants and the dyeing process, a so-called "acid" is printed in—i.e., lime-juice at from 8° to 30° Tw., thickened with an equal weight of starch. Where this is applied, the tissue remains untouched, and, according to the design, may be either left white, or may receive steam, or pigment colours blocked in. Fluosilicic acid is sometimes used instead of citric acid.

"Covers" are small patterns in purple chocolate, &c. (or, rather, in the mordants for producing these colours), printed all over the piece. If, as is often the case, it is wished that these "covers" should not take effect on certain parts of the design which are to be red, &c., the colours for such reds are specially prepared, and are called "resist-reds," &c.

Thus a red "colour" to resist a chocolate "cover" is prepared as follows:—

Resist red liquor at 18° Tw.	6 galls.
Flour	12 lbs.

Boil well, and when nearly cold add—

Tin crystals	6 lbs.
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The resist red liquor above mentioned is obtained with—

Acetate of lime solution at 24° Tw.	90 galls.
Sulphate of alumina, free from iron	272 lbs.
Ground chalk	34 lbs.

In red colours, to resist a purple "cover," the proportion of tin crystals is smaller—

Resist red liquor at 18° Tw., as above	6 galls.
Flour	12 lbs.

Work as before, and add—

Tin crystals	3 lbs.
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There are several modifications of the madder style which still require to be noticed.

Plate purple is the name given to a style composed of black and one or more shades of purple. The grounds are generally padded or well covered, and the designs are mostly small. The following may serve as a specimen: Print on black No. 3, a dark purple, an "acid," and pad in a pale purple. Ageing and dunging are performed in the ordinary manner; the dyeing is executed with alizarine for violets, and the clearing follows with very neutral soap.

Plate pinks consist of alizarine reds and pinks only. Colours are printed in for a dark red and a medium or rose. An "acid" is applied, and the whole "covered" with a very pale red. Many of the precautions required in getting up this style are now no longer necessary, since alizarine has taken the place of the madder root. The very finest "alizarine for reds" should, however, be used.

The GARANCINE STYLE was formerly of great practical importance. It differed from the madder style by using as a colouring matter, not the madder root, but a preparation known as garancine, obtained by treating madder with sulphuric acid and water. A larger relative proportion of colouring matter was thus obtained than from the raw root. Hence this style was, shade for shade, more economical than madder work, in the strict sense of the term. The colours were brilliant, though not quite as permanent as the true madder colours. However, as many of the impurities found in the root were removed or destroyed in the manufacture of garancine, the whites were very little soiled, and the colours did not require so much development or purification upon the fibre, and consequently the operation of "clearing" (*avivage*) was less tedious and severe.

The patterns produced in this style were full and heavy. It dealt largely in browns, brownish reds, combinations of red, black, and chocolate, orange and black, brown and black, scarlet and black. The "colours" printed on were generally weaker by one-third or one-fourth than those re-

quired for corresponding shades in the madder style. Garancine was very generally associated with catechu, without which the browns could not be produced. Quercitron, sumac, the redwoods, &c., also figure in the dyeing process.

It will, of course, be understood that the same effects can now be produced by substituting a smaller quantity of artificial alizarine for the garancine, and reducing the "colours" in proportion.

It may here be mentioned that the tinctorial power of artificial alizarine at 10 per cent. is twenty-four times greater than that of madder, twelve times greater than that of "fleur de garance," and six times greater than that of garancine. These proportions must be regarded in using old receipts where madder root or garancine are employed.

Some of the processes required in the madder style and its modifications must, from their capital importance, be specially explained. These are *ageing*, *dunging*, *clearing*, and *cutting*.

AGEING.

One of the most important processes in calico-printing, at least as far as madder (alizarine) work is concerned, is that known as "ageing." The mordants (technically "colours") printed on in this style contain as their chief ingredients the acetates of alumina and iron, commonly known as red and black liquor. In order that these mordants should be properly fixed upon the fibre, an exposure to air for some time is necessary, the temperature and the degree of moisture in such air requiring to be regulated. The objects of this process are complex; the acetic acid becomes volatilized and escapes, leaving behind it a subsalt of iron or alumina which is more firmly attached to the fibre than when it was first applied; the protoxide of iron in the

black liquor is converted into peroxide by the absorption of oxygen, and catechu-colours also take up the oxygen needed for their development. It is fully shown by experience that imperfect ageing—not to speak of its entire omission—renders the colours meagre and uneven and deficient in fastness and lustre.

This process was at one time performed in enormous chambers known as ageing-rooms. In these chambers the goods sometimes remained for five or six days, hung up in single folds, so as to be in full contact with the hot moist air. It was then found that this exposure in single folds was not necessary, and that the absorption of oxygen, &c., might be sufficiently carried on if the pieces are laid in heaps upon sparred floors in the ageing-room, thus effecting a great saving in space.

A most marked improvement, which reduces the time needed for the process from several days to as many hours, is the ageing-machine introduced by Mr. Thom and Mr. Crum, and now in very general use. This machine, as manufactured by Messrs. Mather and Platt, of Salford, is a chamber thirty-six feet in length, twenty high, and about thirteen broad; through which the pieces travel by means of a system of rollers, at such a rate as to be twenty minutes in passing. The requisite temperature and degree of moisture are kept up by means of steam-pipes fitted with bell-shaped openings for diffusing the vapour.

After this passage through the machine, the pieces are collected in loose bundles and left over-night on the floor of an outside chamber, which is kept at the same degree of heat and moisture as the interior of the machine. The temperature of the ageing-rooms or ageing machines is generally fixed at 70° to 75° or 80° F., the moisture being regulated about 4° lower. For this purpose pairs of dry and wet bulb thermometers are fixed in different parts of the chambers. According to well-known physical laws, the nearer the atmosphere of any place is to saturation

with moisture, the more nearly does the temperature indicated by the wet-bulb thermometer approach that shown by the dry.

If the wet-bulb instrument falls below the point fixed upon as giving the best results, more steam is admitted, but if it approaches too near the temperature the supply of steam is decreased.

In every arrangement of ageing appliances sudden changes of temperature have to be duly guarded against, as a condensation of steam might occasion much trouble. Hence, the doors, windows, and roof of the exterior chamber into which the pieces are removed from the machine are generally made double.

It may be remarked that the chemical and physical changes which take place in ageing are even yet not so fully understood as might be desired, and that there is consequently room here both for chemical and microscopical research.

M. Thierry-Mieg, of Toulouse, proposes to improve the ageing rooms by introducing along with the steam a current of hot air. These heated chambers are to serve both for fixing the mordants printed upon the goods in the madder styles and as a steaming apparatus for steam styles. For the former purpose the idea seems sound. The first purpose of ageing is to fasten the mordants by heat and moisture, removing a portion of the acetic acid so that the iron and alumina may remain in the form of insoluble basic salts. Real oxidation is necessary only in cases of catechu or mordants consisting of proto-acetate or proto-muriate of iron (ferrous acetate and chloride). In both cases the ventilation of the ageing-rooms is often insufficient. The chamber becomes so filled with a vapour of acetic acid that its further escape from the mordants upon the cloth is rendered impossible. The oxygen is used up quickly even in the old rooms, where the pieces hang for two or three days, and this is still more the case in the ageing-machine. It is thus rendered difficult to obtain a

full catechu brown, however strong the colour, because the development of catechu shades requires a certain amount of oxygen, whilst the addition of nitrate of copper to the printing mordant, as an oxidizing agent, cannot be carried beyond certain limits. The introduction of a current of warm air remedies both the imperfect ventilation and the deficiency of oxygen. M. Thierry-Mieg proposes, however, to carry the temperature of the ageing-rooms up to 212° F., which for fixing mordants is not only needless, but in case of aluminous mordants hurtful, as far as present experience goes.

DUNGING.

This process, which is known in French as *dégommage*, follows in madder (alizarine) work after ageing, and has for its object the removal of the thickening matters used in fixing the mordants ("colours"), and which are now of no further use, as well as any excess of mordant which has not become attached to the fibre. For this purpose rinsing in water cannot be tried, since the portions of mordant thus removed would attach themselves to the whites of the design, and in the very common case of several mordants having been printed upon different parts of the same piece, these mordants would become blended, and the design would be ruined. A cleansing fluid or solvent was therefore necessary, which, whilst removing the thickening and useless mordant from the cloth, should at once seize upon and prevent it from attaching itself to the fibre. For this purpose the first agent brought into use was cow-dung (*Bouse de vache*, Kuhkoth), which, according to M. D. Koechlin, has the following effects:—

"It causes the entire combination of the sub-salts (basic salts) of alumina with the fibre of the cloth, causing the separation of nearly all the acetic acid which had not been volatilized off during the drying of the mordant; it separates and removes from the cloth the uncombined portion of the

mordant, and such particles as are merely mechanically held by the thickness; it prevents by the peculiar nature of the substances in its composition the fixing upon the white portions of the cloth of any non-combined mordant which becomes soluble by the acetic acid set free, and which is apt to accumulate in the dung-bath.”¹

The analysis of cow-dung has not revealed any one principle to which these effects can be ascribed. But it evidently contains some substance or substances which prevent alumina and oxide of iron from being precipitated by the usual reagents and from attaching themselves to the cloth.

The use of cow-dung involves several practical difficulties, one of which is procuring a regular supply. It was at one time necessary for a calico-printer, if he made use of the madder style, to keep a large herd of cattle for this purpose—a combination of businesses which was not always profitable or convenient.

Hence cow-dung has been more and more displaced by the dung-substitutes—substances very different in their chemical character, though found in practice to produce the same effects. The chief of these substitutes are the silicate, arsenite, arseniate, and phosphate of soda, and the double phosphate of soda and lime. These substances are used singly or in mixtures.

Whether cow-dung or a substitute is used, it is applied in a warm solution, at temperatures from 112° Fahr. to near the boiling point. The proportions used, are with dung 3 pails to 160—200 pails of water. If the mordants are strongly acid, and the patterns heavy, chalk is generally added. Of the arseniate of soda $1\frac{1}{2}$ to $2\frac{1}{2}$ ozs. per 22 gallons of water is generally sufficient. Whatever the agent selected for dunging, it is necessary that the pieces should travel through the dunging-cistern at a quick rate, spread out perfectly even, and free from any folds or creases. Otherwise the acetic acid and the uncombined

¹ “Bulletin de la Soc. Indust. de Mulhouse.”

mordant might have time to react upon the pieces and injure the shades. After dunging, the pieces are carefully and repeatedly washed.

Very frequently the dunging process is divided into two portions. The first treatment is then spoken of as "fly-dunging," and is followed up by washing, after which the pieces are dunged again. Many precautions have to be taken to suit the process to different kinds of work. If the mordants are strong and highly acid, the dung-bath is made stronger and the operation is more prolonged. For roses and pinks the temperature is kept lower than for full reds, browns or blacks, and less dung is used. Among the substitutes, silicate of soda is sometimes found too alkaline. Some experienced printers contend that even when the substitutes are employed, more satisfactory results are obtained by a final treatment in cow-dung. It is found that if pieces are similarly mordanted and afterwards dyed in the same dye-beck, the shades come up deeper where cow-dung has been employed.

CLEARING.

Clearing, or brightening (*avivage*, French), which must not be confounded with cleansing, is a process which is generally necessary after the dyeing process in all styles, where the entire piece is passed through any colouring beck.

It is in one sense true that, *e.g.*, alizarine has no affinity for unmordanted cotton, and dyes merely where a proper mordant has been printed on. Still, it and many other colours communicate to the whites a stain, which, though dull and feeble, deprives them of their purity, and impairs the effect of the pattern. Besides, in all cases where crude natural products, such as madder, logwood, &c., are used, the colours of the design are dimmed by various matters, which, though not true dyes, attach themselves

loosely to the fibre. It is the object of the clearing process to remove all these stains, so that the whites may be perfectly free from any tinge, and that the colours may be pure.

The clearing is generally effected by successive treatments in hot soap-lyes. The quality of the soap, its proportion, the temperature of the lye, and the time of its action, are all points which require to be very nicely regulated in accordance with experience. As a rule alkaline soaps are to be avoided, especially for madder (alizarine) purples.

Bran is sometimes used as a clearing agent, and more frequently on the Continent than in England. It is generally scalded, and stirred up in water at 140° F., through which the pieces are winced.

Small quantities of permuriate (oxychloride) of tin are often used along with soap in the clearing-becks. Clearing is also, in case of the faster colours, often effected by padding in a solution of chloride of lime at about 1° Tw., steaming for a few minutes at a very low pressure, and very thorough washing. Great care and judgment are needed in managing the operation so that the whites may be cleared without degrading the colours of the design. Whatever be the method of clearing adopted, it should be preceded by very thorough and careful washing.

The clearing process has been very much simplified since alizarine has taken the place of crude madder, as the dyer has no longer to contend with the fawn-coloured matter which was always present in the root.

"CUTTING."

The name "cutting" is given to the process of reducing madder reds, which are intended to come up pink. This process comes after the dyed goods have been soaped, and is again followed by one or more soapings, so that it

may be regarded as a part of the clearing process. The agent employed is stannic chloride (oxymuriate of tin) dissolved in warm water, or sometimes, though less advantageously, sulphuric acid.

Cutting serves not merely to remove any excess of colouring matter, but to brighten and to modify the tone of what remains. It is a process of considerable delicacy.

RESERVED STYLE.

This is a further modification of the madder style. Goods are dyed with any madder shade, but certain spots are left white, and after the dyeing these may be wholly or in part filled up with greens, blues, yellows, &c., in the steam style.

A still greater range of variety may be produced as follows:—There is blocked upon the dyed goods a “reserve paste,” very similar to the “acids” already mentioned under the madder style. The following is used in the case of a red or a black dye:—

Lime-juice at 50° Tw.	3½ quarts.
Soda-lye at 70° Tw	2¼ ”

Boil, and meantime mix separately—

Pipe-clay	14 lbs.
Boiling water	3¾ quarts.

When thoroughly incorporated, add—

Gum Senegal water (at 1½ lb. per quart)	4 quarts.
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Mix both liquids, and let boil together for twenty minutes.

For cases where purples occur, the reserve paste is mixed thus:—

Lime-juice at 60° Tw.	1 gallon.
Soda-lye at 70° Tw.	3 quarts.

Boil and add—

Pipe-clay 12 lbs.

worked up with—

Gum Senegal water (6 lbs. per
gallon) 1 gallon.

Boiling water $\frac{1}{2}$ „

It will be understood that the piece upon which these pastes are applied is not necessarily a self-red, black, purple, &c., but may have a design in reds, chocolates, purples, and blacks, with white spaces.

When the reserve space is dry, a small design in drabs, olives, sages, &c. (“covers,”) may be applied with the machine. The goods are next dunged and dyed with a variety of wares, bark, cochineal, the woods, &c. Where the reserves were printed on the original madder colours, or the white spaces, the covering colours will not have taken effect. Steam or pigment colours may further be blocked in the whites if any have been left.

As specimens of the colours for “covering” the following may be taken:—

Chocolate.

Red liquor at 15° Tw. $1\frac{1}{2}$ gallons.
Black liquor at 24° Tw. 1 quart.
Light British gum 2 lbs. 10 ozs.
Flour 14 ozs.

Drab.

Black liquor at 24° Tw. 1 quart.
Red liquor at 20° Tw. 1 „
Light British gum $2\frac{1}{2}$ lbs.
Water 5 quarts.

Olive.

Red liquor at 18° Tw. $\frac{3}{4}$ gallon.
Light British gum $2\frac{1}{2}$ lbs.
Black liquor at 8° Tw. $\frac{1}{2}$ gallon.

Sage Green.

Red liquor at 9° Tw.	. . .	2½ galls.
Black liquor at 12° Tw.	. . .	1 quart.
Light British gum .	. . .	4 lbs.

PADDING STYLE.

This style is a still further modification of the principle of dyeing upon mordants. The "colour," for the most part red liquor or black liquor, or the two in mixture, is not printed upon some particular portions of the cloth, but is applied to the whole surface by means of the padding machine. The next step is the drying process, which is effected in a so-called padding-flue, an arched chamber of masonry heated from below, and provided with ventilators. Into this vault, which is about 35 yards long, by 4 high and 5 broad, the pieces enter after passing twice through the padding machine. The processes of padding and flue-drying are generally repeated twice, after which the design is produced by printing on an acid discharge which removes the mordant whenever it is applied. In composition these discharges much resemble the "acids" used in the madder style, consisting, *e.g.*, of:—

Lime juice, at 28° Tw.	. . .	1½ gall.
Bisulphate of potash	. . .	24 ozs.

Dissolve, strain, and thicken with 24 ozs. starch.

The next step is ageing, after which follows the dunging to remove the thickenings. It is usual to dung for the first time (so-called *fly-dunging*) at 212° F., then wash and give a second dunging at a lower temperature, say about 160° F., for thirty minutes. They are again washed, dried, and singed to insure a perfectly smooth surface, and are then dyed with mixtures of wares, among which madder (now alizarine) always forms a main ingredient. Where

the acid discharge has been printed on, the dye does not attach itself, and the result is consequently a white design upon a red, purple, &c., ground. It is of course possible to vary the effect by blocking in steam or pigment colours in these white spaces, or the process may be so arranged that a yellow design is produced instead of a white, as will be shown below.

The dyeing process is generally conducted as follows :— The pieces are first run in the cold dye-beck for a short time, and the heat is very gradually raised.

The goods are afterwards rinsed, washed, cleared once or twice by boiling with bran, washed, and dried. The clearing process can be much abridged since pure alizarine has come into use instead of madder root.

If a yellow is to be produced in the spaces where the acid has been printed on, the goods after madder-dyeing and branning, &c., are again padded with red liquor, aged, dunged at a low temperature, say 120° F., washed, and dyed with bark-liquor also at a low temperature, again washed, and dried. The yellow colour of the bark attaches itself to the whites, giving the reds a more fiery tone. This process would not, of course, give desirable results if the ground colour were purple instead of red.

DISCHARGES ON TURKEY REDS.

This style, the last of the general methods of applying the madder-colours, was at one time exceedingly popular. The pieces are first dyed a Turkey red. The design is then printed in discharges which agree chiefly in containing one or more organic acids. If the design produced is not to be white, appropriate pigments or compounds of lead are mixed with the acids. The goods are then taken through a solution of bleaching powder (chloride of lime). The result is that where the acids have been printed on, chlorine gas is liberated, which destroys the Turkey red,

leaving in the simplest cases a white design upon a full red ground. If pigments have been printed in along with the acid discharge, they must, of course, be of a nature not affected by chlorine.

As an instance of a common white discharge for this style we may take the following:—

Tartaric acid solution, at 62° Tw.	. 1 quart.
Acetic acid at 6° Tw.	. 1 „
Thicken with light British gum	. 32 ozs.

The chloride of lime liquor, or as it is technically called the “*decolouring vat*,” generally contains 1 lb. chloride of lime per gallon of water. It must be quite free from lumps and undissolved portions, which would occasion an irregular action. The cistern containing it is fitted with rollers fixed in a movable frame, one at the top and the other at the bottom of the liquid. The printed goods are made to travel through the bleach at the rate of 28 yards per three minutes; they then pass between a pair of nipping rollers and into water, where they are rinsed, and next washed. If a yellow or a green is to be produced in the discharged parts, as in the following examples, the pieces after being rinsed from the decolouring vat, are made to traverse a cistern of weak bichromate of potash, at about 4° Tw. Next they are taken through weak muriatic sours, rinsed, washed, and dried.

For a *yellow* discharge mix:—

Lime-juice at 50° Tw.	. . . 2 quarts.
Tartaric acid . . .	. 2 lbs.
Nitrate of lead . . .	. 2 „

Dissolve and thicken with:—

Pipe-clay	. 24 ozs.
Gum Senegal	. 1½ lb.

If for machine work, starch must be used instead of the pipe-clay and gum.

Blue Discharge.

Tartaric acid	4½ lbs.
Oxalic acid	8 ozs.
Water	3 quarts.
Yellow prussiate of potash	2 lbs.
Copperas	2 lbs.
Starch	1 lb.
Gum tragacanth	2 ozs.

Green discharges are made by combining the blue and the yellow, and of course using the chromate bath.

In this style it is necessary to dry the pieces well before passing them into the chloride of lime vat, and to keep it well stirred up.

INDIGO BLUES. DIP BLUES.

The indigo blues, or as they may be called vat colours, are the last of the great class known by the Germans as *Kessel-farben*, where the entire piece is submitted to a dyeing process. But as indigo in the vat is a substantive colour which attaches itself to the fibre without the aid of a mordant, this style cannot be classed as a case of dyeing upon mordants. Its general characteristic is a blue ground upon which designs are obtained by means of resists and discharges.

In the simplest form this style consists in a deep blue ground with white figures. This effect may be obtained by printing upon the calico a "reserve" of the following character:—

Blue-stone	5 lbs.
Water	2 galls.
Dark British gum	4 lbs.
Flour	18 lbs.

If the reserve is to be applied with the block instead of

with the machine, pipe-clay along with a little gum may be used as a thickener.

When this reserve paste has been printed on, the pieces are vatted up to shade, after being previously hung up for about forty-eight hours in a slightly damp atmosphere.

If only pale blue shades have to be resisted, the following mixture will shade the character of the reserve paste to be used :—

Dissolve dark gum substitute	32 lbs.
In water	3 $\frac{1}{4}$ galls.

Boil, and add :—

Soft soap	8 lbs.
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Let cool, and add :—

Sulphate of zinc	24 lbs.
Boiling water	2 galls.
Nitrate of copper at 80° Tw.	1 gall.

A slight variation in the composition of the reserves renders it possible to produce yellow or orange, and consequently green designs upon the usual blue ground. Thus for a yellow take :—

Blue-stone	5 lbs.
Nitrate of lead	5 „
Water	2 quarts.

When dissolved thicken with :—

Flour	3 lbs.
Paste sulphate of lead	$\frac{1}{2}$ gall.

The paste sulphate is the sediment left after preparing red liquor with acetate of lead and sulphate of alumina. It is generally set aside for such purposes.

•
Orange.

A solution of basic sugar of lead (subacetate of lead) is

used instead of the water mentioned in the receipt for yellows. It is made by dissolving sugar of lead in water, stirring in by degrees half the weight of litharge, letting settle in a covered vessel to exclude carbonic acid, and drawing off the clear for use.

After this yellow resist is printed on, the goods are vatted to the intended shade, taken through vitriol sours, washed, and winced for ten minutes in a cistern of bichromate of potash at 100° F., containing $\frac{1}{2}$ lb. per 8 gallons. Wash well, take through muriatic acid at $\frac{1}{2}$ ° Tw., containing $\frac{1}{4}$ lb. oxalic acid per 8 gallons. Wash, and dry.

In case of orange the process is the same; but after passing through the muriatic sours, the pieces are further taken through the following raising or brightening beck:—

Bichromate of potash.	.	.	.	20 lbs.
Lime, just slaked	.	.	.	7 lbs.
Water	.	.	.	60 galls.

Heat to 180° F., run pieces through till the orange is bright, wash, and dry.

For a green design print on the reserve as given above for yellows; vat to shade. Take through weak vitriol sours, and through chromate, but not through the muriatic oxalic sours, as directed under yellows.

If it is desired to produce a design in white and dark blue upon a light blue ground, the parts that are to come out a dark blue are printed with "bronze salt" (sulphate of manganese) or muriate (chloride) of manganese, thickened with dark gum substitute. After printing and drying, the pieces are taken through soda lye, washed, and then winced through a clear solution of chloride of lime at 2° Tw., till the design appears entirely and regularly brown. The goods are then dried, and the whites of the design are printed on with the proper reserve as above mentioned. They are then limed, vatted to shade, aired to bring up the blue, washed, taken through muriatic sours

at $\frac{1}{2}^{\circ}$ Tw., to which has been added a small proportion of tin crystals, again washed, and dried. A dark blue appears where the indigo has been deposited over the manganese ground.

From the examples given it will be easily seen how varied effects may be produced in this style by the combination of yellow, orange, green, and white with one or two shades of blue.

The vat generally used is the ordinary copperas vat. It will be, of course, understood that in the whites steam colours of any kind may be afterwards blocked in.

As instances of discharge effects on a vat blue ground, the following may be taken:—

Red and white discharge (Steiner's process).

Vat in 6 to 8 dips.

Steep in bichromate of potash at $4\frac{1}{4}$ ozs. per $1\frac{3}{4}$ pint water, and dry on rollers in hot flue, avoiding the sun. Print on the following:—

White discharge.

Water	7 pints.
White starch	2 lbs. 8 ozs.

Boil, and add when lukewarm—

Tartaric acid	2 lbs. 3 ozs.
Oxalic acid	$21\frac{1}{2}$ ozs.

dissolved in $1\frac{3}{4}$ pint water.

Red discharge.

Red liquor	28 pints.
White starch	$17\frac{1}{2}$ lbs.

Boil, let the one half grow cold, and add—

Oxalic acid	7 lbs. 10 ozs.
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Then add the other half of the hot mixture to finish the solution of the oxalic acid.

The red liquor used is made by taking alum and acetate of lead, 2 lbs. 3 ozs. each, and dissolving in $3\frac{1}{2}$ pints water.

These discharges are printed on with a two-colour machine, dried not too strongly, aged in hot, but not moist, air, and the next morning dunged with—

Neutral arseniate of soda		6 lbs. 9 ozs.
Chalk		27 lbs. 5 ozs.
Water		1,750 pints.

Pass slowly through at a simmer, so as to keep the chalk from settling. On leaving the dung cistern, nip strongly between rollers covered with cloth. After the first five pieces have passed, feed the beck with $1\frac{1}{4}$ oz. arseniate of soda, and a little chalk per piece. Cleanse, and dye up with alizarine, adding quercitron bark and woods if required; pass through boiling bran. It must be noted that the oxalate of alumina formed in preparing the red is very hygrometric, whence the necessity of having the pieces perfectly dry before dunging.

Instead of the red discharge directed above, the following may be used:—Dissolve oxalic acid in hot white starch paste, and, when cold, add perchloride of tin (stannic chloride or oxymuriate of tin). Print, and do *not* dry very strongly. Dung in chalk and silicate of soda, or chalk alone. Wash, and dye up with alizarine.

Orange discharge on Dark Vat Blues.

After vatting, print on—

Water		$3\frac{1}{4}$ pints.
White starch		14 ozs.
Sugar of lead		4 lbs. 6 ozs.
Precipitated manganese		6 lbs. 9 ozs.

The precipitated manganese is obtained as follows:—

Water	5 $\frac{1}{4}$ pints.
Chloride of lime at 20° Tw.	3 $\frac{1}{2}$ pints.

Then add—

Water	2 $\frac{1}{2}$ pints.
Chloride of manganese at 224° Tw.	1 $\frac{3}{4}$ pint.
Muriatic acid	1 $\frac{1}{4}$ oz.

This precipitate, which should be of a deep brown, is washed with water by decantation three or four times, and filtered. The pieces, after printing, are taken through muriatic sours at 8° Tw.; then into weak copperas water; then into lime-water, steeped in bichromate of potash; and finally raised with chlorite of lime at a boil.

It is to be noticed that the colours produced by indigo upon cottons, whatever may be the process employed, are dull and unpleasant. Hence this style and all its modifications have fallen into disuse, except for low qualities of goods. We must, however, remember that the recent researches of Professor Baeyer on artificial indigo open up a prospect of the preparation of substitution derivatives of indigotine (indigo blue) no less fast than the original colour, but at the same time brighter. Herein, in the writer's opinion, and in the production of indigo-blue on the fibre (*see* China-blue style), lies the great technical significance of Professor Baeyer's investigations.

A modification of indigo work is the so-called Lazulite, neutral, or lapis style. In this process mordants ("colours"), as in madder work, are printed in along with reserves, and the goods are vatted. The colours resist the vat, and may be afterwards dyed up with alizarine, &c. There are here two cases: sometimes colours for red, black, &c., are printed with a reserve white which has merely to resist the blue of the vat, and, secondly, the madder dye has to be resisted as well as the vat.

The lazulite style is at present in very little request;

but as the process is instructive, and as fashion may revive it at any moment, it should not be overlooked.

White Resist for Block and Cylinder Work.

Water	5 $\frac{1}{4}$ pints.
Lime-juice at 53° Tw.	6 lbs. 9 ozs.
Pipe-clay	11 lbs.

Mix separately:—

Water	5 $\frac{1}{4}$ pints.
Lime-juice at 53° Tw.	4 lbs. 6 ozs.
Corrosive sublimate	3 lbs. 13 ozs.
Calcined starch	11 lbs.
Lard	12 $\frac{3}{4}$ ozs.
Oil of turpentine	6 $\frac{3}{8}$ ozs.
Muriate of zinc at 98° Tw.	3 $\frac{1}{4}$ lbs.

Mix and boil.

Red Resist for Block and Cylinder Work.

Red liquor	7 pints.
Verdigris	6 $\frac{1}{2}$ ozs.
Pipe-clay	9 lbs. 13 ozs.
Lard	4 $\frac{7}{8}$ ozs.
Turpentine	4 $\frac{7}{8}$ ozs.

Dissolve separately:—

White arsenic	12 $\frac{3}{4}$ ozs.
Red liquor	5 $\frac{1}{4}$ pints.

Mix also apart:—

Red liquor	3 $\frac{1}{2}$ pints.
Gum Senegal	3 $\frac{1}{4}$ lbs.
Muriate of zinc at 98° Tw.	17 $\frac{1}{2}$ ozs.
Extract of logwood at 7° Tw.	9 „

Incorporate these three portions with the aid of heat, strain, and print. The author, M. A. Schultz, directs the mixture to be ground for twelve hours before using.

White Lapis Resist for Heavy Patterns.

Water	7 pints.
Arsenate of soda	3 lbs. 5 ozs.
Corrosive sublimate	11 $\frac{3}{4}$ ozs.

Dissolve with heat.

Put separately in a larger pan :—

Pipe-clay	6 lbs. 9 ozs.
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Gradually add three-quarters of the above solution whilst the clay is being beaten up. Stir well, and add the rest of the solution ; stir well again after the addition, and mix separately :—

Rosin	11 $\frac{3}{4}$ ozs.
Fine grease	11 $\frac{3}{4}$ „

Melt together and heat to a boil, and stir into the above mixture ; stir again, and add :—

Gum water (containing 6 lbs. 9 ozs. gum)	5 $\frac{1}{4}$ pints.
Add water	1 $\frac{3}{4}$ „

Heat to 140°—158° F., and strain when cold. Add a little extract of indigo to sighten.

Red Resist for Heavy Patterns.

Water	7 pints.
Alum	5 lbs. 7 ozs.
Sugar of lead	3 lbs. 13 ozs.

Put separately in a large colour pan :—

Pipe-clay	6 lbs.
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Beat up with three-fourths of the above solution, and a considerable time before adding the rest add:—

Best verdigris 6½ ozs.

Previously soaked in—

Water 23 fluid ozs.

Extract of St. Martha-wood

at 6¼° Tw. 17½ fluid ozs.

Melt separately:—

Fine grease 17½ ozs.

Resin 3½ „

Boil up in a small pan and pour briskly into the colour, stir well, and add gum-water (containing ¾ lbs. gum) 3 pints.

Heat to 140°—158° F. for half an hour, and strain when cold.

Puce Lapis Resist.

Red liquor at 12½ Tw. 7 pints.

Black liquor at 21½ Tw. 5½ „

Sal-ammoniac 6½ ozs.

Heat a little, and add:—

Blue-stone 8¾ ozs.

Heat again, and add:—

Verdigris 8¾ ozs.

Add by degrees:—

Pipe-clay 4lbs. 6 ozs.

Gum-water (containing 5 lbs.

7 ozs. gum) 4 pints 7 ozs.

Water 17 ozs.

Catechu Lapis Resist.

Water 4 pints 7 fluid ozs.

Pale catechu 19¼ ozs.

Fine verdigris 4¾ „

Boil for fifteen minutes; cease boiling, and add:—

Acetic acid (containing 40 per cent of the glacial acid)	17½ ozs.
Sal-ammoniac	4¼ „

Work up in another pan 4 lbs. 6 ozs. pipe-clay with the above mixture, and stir well. Boil separately:—

Grease	9¾ ozs.
Resin	5⅔ ozs.

and pour it into the colour. Add lastly:—

Gum-water (containing 6 lbs. 9 ozs. gum)	5½ pints.
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Lapis Black.

Black liquor at 18½° Tw.	52½ pints.
Water	52½ „
White starch	17½ lbs.

Boil for an hour, and add:—

Common verdigris	2 lbs. 3 ozs.
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Previously dissolved in:—

Acetic acid	3½ pints.
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Boil for fifteen minutes. This black keeps eight days.

In printing lapis resists with the machine, the mercury of the corrosive sublimate, where present, whitens the copper cylinders, a part of the sublimate being decomposed.

The printing is done with rollers which are very deeply engraved. The pieces are afterwards aged at a heat of 95° F. with the wet-bulb thermometer at 89° F.

They are next dried for twelve hours at 76° F. This is a very important part of the process, since if the pieces remain damp the colours are soaked through and resist the indigo very imperfectly.

They are then vatted to the desired shade, washed for a quarter of an hour in a current of water, and fly-dunged

in folds for thirty minutes in a cistern at 140°F. , with four pails of dung and $15\frac{1}{4}$ lbs. chalk per six pieces. Wash, and dung again in the same manner, but without chalk. Wash again.

The next step is the dyeing, formerly done with garancine, associated with other colouring matters as may be required, such as lima-wood, sapan, bark, sumac, &c. Artificial alizarine now takes the place of garancine.

After washing till the pieces give off no more colour, they are taken, if needful, through chloride of lime at $\frac{1}{2}^{\circ}\text{Tw.}$ Wash, dry, and block in yellows if they occur in the design. Age for twenty-four hours at 86°F. with the wet-bulb thermometer at 80°F. Wash, dry, and finish.

The following process is in use at Rouen. The pieces are vatted, steeped in bichromate of potash, and dried in the hot flue or on steam plates. The following discharge is then printed on:—

Red liquor at 14°Tw.	.	.	.	.	$1\frac{3}{4}$ pint.
White starch	.	.	.	.	$5\frac{1}{4}$ ozs.
Oxalic acid	.	.	.	.	$7\frac{1}{2}$ „

After printing, take through ammonia water, dung, and dye with alizarine. Of course steam, spirit, or pigment colours may be blocked in.

Mr. J. Lightfoot, the discoverer of aniline black, invented a very interesting manner of applying indigo in combination with the madder colours (Patent Specification No. 3668, Dec. 26th, 1867).

The inventor takes dry indigo, ground and prepared, $1\frac{1}{4}$ lb., or if a moist ground indigo is used, such a weight as may contain that weight of dry indigo; tin crystals $1\frac{1}{4}$ lb., caustic soda at 30°Tw. , or caustic potash, at 40°Tw. , 1 gallon. These ingredients are put in a colour pan and raised to a boil; in half an hour a gallon of boiling water is added, and the mixture is let stand till quite cold. Three gallons of cold water are next added, in which has been previously dissolved $\frac{1}{2}$ lb. sugar. He then adds $2\frac{1}{2}$ pints of

muriatic acid at 32° Tw., and 1 pint ordinary sulphuric acid diluted with an equal measure of water, and let stand till clear and quite cold; or else 3 quarts of acetic acid at 8° Tw.

A precipitate of indigotine may also be obtained by a mixture of $\frac{1}{4}$ pint double muriate of tin at 120° to half the quantity of acid mentioned above. Acetic acid alone is, however, preferable to all other agents for this purpose. The precipitate of indigotine (indigo blue) thus obtained is filtered through a deep, cone-shaped filter, so that the smallest possible surface may be exposed to the air. The quantity of pulp from the above proportions should, when filtered and drained, be 1 gallon.

For a blue printing colour Mr. Lightfoot mixes 4 galls. of the above pulp, and 14 lbs. powdered gum Senegal, stirring till dissolved, strains, and prints.

For a green he takes $4\frac{1}{2}$ galls. of the indigotine pulp, 18 lbs. ground gum Senegal, which is stirred in till dissolved; 11 lbs. nitrate of lead and 11 lbs. white sugar of lead, both ground, are added, the mixture stirred till all the ingredients are dissolved, and strained.

The blue and green just mentioned and the usual iron and alum mordants as used for madder work are printed on the pieces, which, after cooling, are aged for a night. They are then fixed by passing through silicate of soda at 8° Tw., or silicate of potash at 12° Tw., to which 1 oz. powdered chalk is added per gallon. This dunging bath is heated to 90° F., and is used in a cistern fitted with rollers at top and bottom, through which the pieces pass at the rate of 25 yards per minute. After this process they are winced in a tank of cold water, fitted with a reel fixed about four feet above the surface, thus rendering the indigotine attached to the fibre perfectly blue. If the green mixture has been used, the pieces are passed into a cistern of bichromate of potash containing 1 oz. of the dry salt per gallon of water at 100° F. for five minutes, and are then washed. Then follows the second dunging for twelve to fifteen minutes in a cistern of cow-dung and water at 100°. The

pieces are next washed and are then ready to be dyed with madder, or any of its preparations or derivatives, cochineal, mixtures of alizarine with sumac and bark, &c. They are subsequently treated in the ordinary manner, the grounds, if soiled, being cleared with weak chloride of lime.

By this process beautiful furniture prints can be produced.

The BRONZE STYLE, generally known on the Continent as the *Bistre style*, is at present in abeyance. Its characteristic feature is a deep blackish ground, produced by means of the hydrated peroxide of manganese, upon which a variety of discharge colours are afterwards printed. The first operation is to pad the pieces in a solution of bronze salt (sulphate of manganese or chloride of manganese), at about 80° Tw. They are next dried and padded twice in soda lye, the first time at 24° Tw., and the second at 12° Tw. The purpose of this treatment is to decompose the bronze salt and deposit oxide of manganese upon the fibre. The pieces are next winced in water, and then in solution of chloride of lime at 2° Tw. This operation converts the oxide of manganese upon the fibre into hydrated peroxide, and is continued until the cloth appears of a uniform brown. After washing in water and drying, the design is printed in colours which discharge the brown and leave white, or yellow, blue, green, pink, &c., in its place. As instances of the colours used, may be mentioned:—

White.

Light gum substitute	.	.	4 lbs.
Water	.	.	4 quarts.

Dissolve at a boil, and add—

Double muriate of tin at 120° Tw.	2 quarts.
Tartaric acid	4 lbs.

Light Red.

Peachwood liquor at 12° Tw.		$\frac{1}{2}$ gallon.
Blue-stone		1 oz.
Sal-ammoniac		1 oz.
Starch		1 lb.

Dissolve at a boil, and add—

Permuriate of tin (stannic chloride) at 120° Tw.		4 fl. oz.
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Two parts by measure of this colour are mixed for use with one part double muriate of tin (stannous chloride) at 120° Tw.

The object of the proto-salt of tin in all these cases is to reduce the peroxide of manganese to a protoxide, which is then dissolved by the acids present, and washed away, whilst in every case save white, another colour is deposited in its stead.

Blue.

Yellow prussiate of potash		7 $\frac{1}{2}$ lbs.
Water		48 quarts.
Starch		20 lbs.
Light gum substitute		12 „

Boil till dissolved, and stir in—

Tartaric acid		24 lbs.
Oxalic acid		12 „
Nitrate of iron		2 $\frac{1}{2}$ quarts.

When about to be used 5 measures of this mixture are added to 3 measures double muriate of tin at 120° Tw.

Yellow.

Nitrate of lead		10 lbs.
Light gum substitute		8 „
Water		2 gallons.

Boil till dissolved, and stir in—

Tartaric acid 8 lbs.

For use, one measure of double muriate of tin at 120° Tw. is mixed with three measures of the above colour. This colour requires to be followed up with bichromate of potash, as will be shown below.

Green.

Blue, omitting the tin	1 gallon.
Yellow, do. do.	$\frac{1}{2}$ „
Double muriate at 120° Tw.	$\frac{1}{2}$ „

Black.

Copperas	$1\frac{1}{4}$ lb.
Logwood liquor at 8° Tw.	2 gallons.
Water	2 „
Starch	3 lbs.

Boil till dissolved, and stir in—

Nitrate of iron at 80° Tw. 1 pint.

The black requires no proto-salt of tin, since here the object is not to remove the brown peroxide of manganese, but to top it with a darker colour.

After printing the pieces are allowed to hang for a short time, well rinsed, taken through milk of chalk, again through water, and in case of greens and yellows, through bichromate of potash at 4° Tw. They are next washed and dried.

This style has undergone no recent improvements, and is described as it was practised twenty years ago. Should it again become fashionable, it would admit of many modifications.

CHINA BLUE STYLE.

This style consists in the production of indigo blue patterns on a white ground.

Probably the best method of preparing and applying the indigo is that based upon the "hydrosulphite" process of MM. Schützenberger and De Lalande. To prepare the hydrosulphite of soda, zinc turnings or filings are placed in a covered vessel, and there is poured upon them a solution of bisulphite of soda at 54° Tw. The vessel must stand for at least an hour, and the contents should be well stirred up three times. The liquid which marks 60° Tw. is run off. The zinc remaining in the vessel is then covered with water, which must be poured away when fresh bisulphite is to be introduced. From time to time the zinc requires to be renewed, as every 2 lbs. 3 ozs. of the bisulphite of soda introduced, dissolves away about $1\frac{1}{4}$ oz of the metal. Next pour into a closed vessel 12 ozs. milk of lime, containing per $1\frac{3}{4}$ pint, 7 ozs. quicklime, and 2 lbs. 3 ozs. of the "hydrosulphite," as prepared above. Stir well, and cool to prevent rise of temperature. The mass should have an alkaline reaction. When it is to be used, the contents of the vessel are thrown upon a linen filter, in which the residue is afterwards pressed. The clear liquid stands at 35° Tw.

To reduce the indigo, 4 lbs. 6 ozs. good Bengal indigo are ground up in the ordinary manner, using water enough to make up 35 pints. This is placed in a boiler, made up with water to 100 to 140 pints, and 11 lbs. 9 ozs. soda-lye at 49° Tw. and $30\frac{3}{4}$ lbs. hydrosulphite are added. The mixture is then heated for fifteen to twenty minutes, up to 158°F. Then $6\frac{1}{2}$ pints of muriatic acid are poured in through a long-necked funnel reaching to the bottom of the vessel, which should be placed in the open air or under a good draught-hood. If the liquid has a faintly acid reaction the decomposition is complete, and the whole is poured into a

vat capable of holding 140 quarts, which is then filled up with water. The next morning the liquid standing above the precipitate is run off through plug-holes in the side of the vat till the bottom is only covered to the depth of $2\frac{1}{2}$ inches. The vat is then again filled up with water, to which $\frac{1}{4}$ per cent. by measure of a saturated solution of the hydrosulphite has been added. The next day the water is again run off, and the sediment is thrown upon a filter and washed. When completely drained, we obtain for every 2 lbs. of indigo originally employed, 7 lbs. of a stiff paste. To preserve this paste it is suspended in gum-water. For this purpose take 7 lbs. of paste, and mix it with 20 lbs. of thick gum-water. Thus we obtain 27 lbs. of gum-water, containing 2 lbs. indigo. M. O. Gros-Renaud names this mixture *bleu-gomme*, and he prefers for this purpose gum Senegal, as starch, British gum, and tragacanth do not give satisfactory results.

Direct printing colours may be made up, however, without the use of *bleu-gomme* as follows:—

Put in a colour-pan 8 lbs. 3 ozs. indigo, ground in water so as to take 58 pints of liquid. Heat, and add:—

Ground gum 6 lb. 9 ozs.

Dissolve, and add:—

Saturated hydrosulphite . . . 11 lbs.
Milk of lime 15 $\frac{1}{2}$ fl. ozs.

containing 7 ozs. lime per 1 $\frac{3}{4}$ pint. Heat for twenty minutes to 158° F., cool down to 104° F., and add:—

Saturated hydrosulphite . . . 3 $\frac{1}{4}$ lbs.
Milk of lime 15 $\frac{1}{2}$ ozs.

The yield is 30 $\frac{1}{4}$ lbs. colour.

Colour made up with bleu-gomme.

Bleu-gomme	20 lbs.
Acid hydrosulphite	6 „
Milk of lime	3½ lbs.
Saturated hydrosulphite	5½ „
Water or gum-water	2 „

Colour . 36 lbs.

Heat in a water bath to 86°—95° F.

These colours must always be printed warm, at about 90° F. Nor must they be used too soon after being mixed. Those colours give the best results which show a slightly greenish colour till the next morning:

After printing, the pieces are spread out over-night to air, or, if needful, they may be at once taken through a weak chrome beck at a hand-heat. In either case they are thoroughly well rinsed, washed, and soaped, for thirty to forty-five minutes at 122° to 148° F. If the whites are not good they are passed through a chemiac bath (chloride of lime) till clear. If the hydrosulphite blue is printed along with other colours, the pieces may undergo the processes needful for such colours without any regard being paid to the blue. Passing through caustic soda, vitriol-sours, chrome, warm, cold, or alkaline, silicate of soda, phosphates of lime and soda, cow-dung, &c., has no effect upon the hydrosulphite blue. Hence, *e.g.*, it can be combined with alizarine work without any difficulty.

It may be remarked that MM. Schützenberger and De Lalande have assigned their British patents for the hydrosulphite vat process to Messrs. Reid, Halliday, and Sons, of Huddersfield, who, we believe, supply the hydrosulphite of lime, and, if required, the indigo-paste.

It must be remembered that some writers in this country call the “hydrosulphites” of Schützenberger and De Lalande

"hyposulphites," whilst the substances which formerly bore that name rank as "thiosulphites."

Blues printed with the hydrosulphite process can be combined with aniline black, naphthylamine puce, chrome orange, spirit or chrome catechu, alizarine red, lilac and puce, discharge reds with a blue ground, and discharge whites with a blue ground,

Fast blues may also be printed upon cotton and linen by means of "Guthier and Goetzes' concentrated vat," a liquid supplied direct to consumers by the inventors, who have not made known the process by which it is prepared. The printing colour is obtained by thickening the "concentrated vat" with gum or dextrine, and adding to the mixture a sufficient quantity of "solution." The printing is conducted in the air with the ordinary machine, and oxidation is said to be so kept down that the colour in the trough of a machine after working for an hour still remains yellow, whilst the indigo is fixed and oxidized at once as printed on. Fast blues can be produced in this manner along with most other styles, such as madder work, aniline black, catechu, pigments, &c.

Printing with Artificial Indigo.

This process is, strictly speaking, the production of indigotine upon the fibre.

A standard is made by mixing well 4 lbs. propiolic acid paste (equal to 1 lb. dry propiolic acid) and 1 lb. borax in fine powder. The mixture first liquefies, and then turns stiff. Add 3 quarts white starch thickening (wheat starch), mix well, and strain.

To make up the printing-colour, take the above standard and immediately before printing dissolve in it $1\frac{1}{2}$ lbs. xanthate of soda, and stir well.

For lighter shades reduce the above colour with the following: in 1 gallon white starch paste dissolve 1 lb. xanthate of soda.

Print and dry as usual. The pieces must not come in contact with the drying cylinders, or be heated to above 212° F. The indigo blue is best developed by allowing the printed goods to remain for forty-eight hours in a dry atmosphere, and at a common temperature. Damp air should be as much as possible excluded until the colour is fully developed. Then the goods may be passed through the ageing-machine, or steamed at a low pressure if such treatment is needed for fixing any other colour or mordant printed on along with the indigo-blue.

After the blue is developed, the pieces are first thoroughly washed in the machine, and then boiled in a solution of hyposulphite of soda, 1 lb. to 10 gallons water, for half an hour, in order to drive off a smell which otherwise clings to the goods.

Clear in a soap-bath at a heat 104° F., wash, dry, and finish.

Wheat starch gives the best results as a thickener; next follows gum tragacanth. The colour is considerably reduced by using gum Senegal, dark British gum, or calcined farina as thickeners.

Instead of borax there may be used, though less satisfactorily, 1 lb. to 1½ lb. acetate of soda.

The standard keeps unchanged for any length of time, but when mixed with its full proportion of xanthate of soda it gradually loses strength after a few hours.

Propiolic acid may be printed along with aniline black, catechu browns, and drabs, and with alumina and iron mordants for alizarine colours.

After the indigo-blue is fully developed, the mordants are fixed in the ordinary manner, dyed with alizarine, padded with alizarine oil, steamed, and otherwise treated as usual.

Indigo-blue, whether natural or artificial, is injured by prolonged steaming at high pressure. Hence only such colours can be worked along with propiolic acid as can be fixed by short steaming at a low pressure.

Another process is to dissolve 2 lbs. xanthate of soda in 1 gallon cold water. Pad the goods in this liquid, dry,

print with standard, and then treat as above directed. The pieces may also be first printed with xanthate of soda, and then covered with standard. (See paper read by Prof. Rdscoe, F.R.S., before the Royal Institution, May 27th, 1881.)

STEAMING PROCESS.

In the so-called steam and pigment styles the fixation of the colours is effected chiefly by their being exposed to the action of steam in a suitable apparatus. Of this there are two distinct kinds, each of which has its advocates.

The steam-column is a cylindrical case of sheet copper, generally about forty-four inches in length, by from three to five in diameter. It is punctured all over with holes of about one-sixteenth of an inch in diameter, and placed at about a quarter of an inch apart from each other. It is connected below with a pipe, leading to a steam boiler, and fitted with a cock for turning steam on and off as may be required. At the bottom of the cylinder is fixed a circular plate about ten inches in diameter, traversed by the afore-said steam-pipe, and serving to keep the pieces in their place when folded round the column. Sometimes, however, the steam is admitted at the top; and in any case there are arrangements for permitting the escape of the condensed steam-water.

In using this apparatus the cylinder is first wrapped in several folds of blanketing, then in some coils of plain cotton, and then the printed goods are folded round it, the pieces being stitched end to end, so as to form a continuous web. Over all comes a layer of plain calico. For convenience in folding these tissues round the cylinder it is unscrewed from the steam-pipe, laid horizontally, and made to rotate in a kind of framework. When dressed, it is fixed upright in its place, connected with the pipe, and the steam is turned on. The length of the steaming process is generally from twenty to thirty minutes, and is regulated by the

nature of the colours; the more salts of tin are present, the shorter must be the process, lest the cloth should be attacked, or, as it is technically called, "tendered."

As soon as the steam is shut off the column is disconnected, and the pieces are at once unrolled and exposed to the air to dry. If left upon the cylinder, the colours might be caused to run, in consequence of the condensation of moisture.

The column seems to be more in favour in France than in England.

The apparatus generally used in this country is the steam-chest. This is a horizontal chamber of sheet iron, of from 10 to 12 feet in length, 6 to 8 feet in width, and 8 to 9 feet in height. Its form is somewhat cylindrical. This chamber is permanently closed at one end, and is fitted at the other with tightly closing iron doors, arranged so that they can be fastened, air and steam-tight, by means of screws. These doors, when unscrewed, can generally be raised after the manner of a portcullis, by means of a counterpoise and chain running over pulleys. The steam is admitted by means of a pipe pierced with many fine holes, and running from end to end of the chamber, but beneath a false bottom, also perforated. In this manner the steam is equally diffused throughout the chamber. At some little distance from the top there is an interior roof, which does not come quite to the sides of the chamber. If steam condenses above, the drops fall upon this false roof, and are thus prevented from descending upon the goods during the process. The chamber is fitted with a safety-valve and a gauge, for the purpose of regulating the pressure, a point of considerable importance. It is often requisite to begin steaming with a gentle pressure, say about $\frac{1}{4}$ atmosphere, and increase it gradually to $\frac{1}{2}$ atmosphere. In many receipts for steam-colours, the special pressures which give the best results are indicated.

The steam-chest is charged with pieces by means of the following arrangement:—On the false bottom of the chest

are fixed a pair of rails, which extend out into the room. Upon these is set an iron or wooden framework, travelling upon wheels, and long enough to fit the inside of the chest, and about six feet in height by four in breadth. The pieces are coiled one after another upon a reel, the selvages of all the folds being carefully kept parallel. They are then drawn off the reel, flattened, cords terminating in loops are passed through all the selvages, and attached by means of the loops to rods resting laterally on the frame, the pieces all hanging selvege downwards. When the framework or carriage is thus filled, it is run along the rails into the chest, the doors are closed and screwed up, and the steam turned on for such time and at such pressure as is required. When the time is expired the steam is shut off, the doors opened, the carriage run out, and the pieces unfolded and laid ready for the washing-off, which is in a great number of cases followed by a passage through a very weak cistern of bichromate of potash.

One advantage of the chest as compared with the column is that a very much greater number of pieces may be steamed with the same, or nearly the same, quantity of labour.

It may be here remarked that, in order to have the steam perfectly saturated with moisture, some printers cause it to pass through water immediately before entering the steam-chest. An apparatus, which the inventor considers will serve at once the purposes of steaming and ageing, has been noticed under the latter head.

Cordillot and Mather propose a continuous process for colours which do not require a high pressure. The carriages or frames for the pieces run on rails as usual, but have their entrance and egress on opposite sides. The pieces to be steamed are delivered into the chest or chamber over a feed roller and two small guide rollers at full width. The pieces traverse the chambers on rollers two or three times, and are then delivered into the car-

riage. When this is full, the door is opened, and another carriage is introduced which pushes the full one along, and receives the pieces in its turn, until the first carriage has been long enough in the steam. It is then expelled at the departure door, and a fresh empty carriage is introduced at the entrance door.

It appears that alizarine styles, if piled loosely, and made thoroughly hot, can be steamed in a heap. This point the patentees effect by letting the goods travel a considerable distance in the hot and moist atmosphere of the chamber. The rollers are specially heated to prevent injury from drops of condensed water. The steam is thoroughly moistened before entering the chest.

A continuous steaming process has been devised by Mr. Smith. The chest is a rectangular chamber of masonry, the roof being vaulted or supported by girders. The pieces are passed mechanically into the chamber, and hang in loose folds on transverse rods, whose ends rest on two horizontal endless chains, placed parallel to each other. There are special arrangements for supporting the bearing-rods, and keeping them at a suitable distance from each other. The chains travel on at a speed which can be regulated; and as each rod reaches the end, the goods are withdrawn, and the rod detached from the chain.

The degree of pressure of the steam in the steam process is a very important point. It is specified in three distinct ways, *i.e.*, either as so many pounds to the square inch, or as $\frac{1}{2}$, $\frac{3}{4}$, 1, or $1\frac{1}{4}$, &c., atmospheres, or according to the temperature of the steam-chest. These various standards are mutually convertible. At 212° F., and at the common pressure of the atmosphere, "1 atmosphere" means a pressure of 15 lbs. to the square inch (in strict accuracy, $14\cdot7$ lbs.). Hence $\frac{1}{2}$ atmosphere is equivalent to $7\frac{1}{2}$ lbs., &c. At a temperature of 216° F., the pressure is = 16 lbs. per square inch; at 230° F. = 21 lbs. Higher temperatures and pressures are rarely needful, or even admissible, as very

hot steam not merely effects chemical changes in the colours and mordants, but even begins to attack the fibre of silk and wool.

An apparatus very much used in France, both for wool, silk, and mixed goods, is arranged as follows:—The steam-chamber is constructed either of wood or of bricks covered with cement; it is about $6\frac{1}{2}$ feet high, and in length and width it is regulated by the quantity of pieces generally produced, and their size. The steam in the boiler is at $5\frac{1}{2}$ atmospheres, and in the condenser $4\frac{1}{2}$. It is admitted by pipes fitted with a pressure-gauge and discs, which allow the steam to be regulated. To the outside of the chamber is fixed a dial showing the pressure. The bottom of the chest is double, forming a chamber which can be filled with water, and the top of which is covered with a wrapper. At the top are a series of copper rollers covered with cloth, which can be lifted out of their places to receive the goods previously rolled up with back-cloths on a reel, and can then be returned. When the rollers are fixed on their pivots, they allow the pieces to hang down nearly to the bottom of the chest. For styles with chromic orange, the back-cloths (doubliers) are prepared with sugar of lead. (It has been elsewhere shown that, by the addition of the nitrate of cadmium to the orange colour, the necessity for these doubliers is done away with.) For acid colours, they are steeped in the following mixture:—

Chalk.	.	.	.	.	.	5 parts.
Dextrine	:	:	:	:	:	$7\frac{1}{2}$ "
Water.	.	.	.	.	.	100 "

About 1 lb. chalk is sufficient for each cloth. After this treatment, they are dried. Old cloths are passed only once through this mixture, but new ones require to be passed twice.

For alizarine colours, the steam is turned on at a very

low pressure, and is increased every twenty minutes, up to $\frac{1}{2}$ atmosphere.

For silks, the process of steaming with the column or cylinder is not to be recommended. The pressure does not exceed 1 atmosphere; and for cochineal red grounds, does not exceed $\frac{1}{4}$ atmosphere.

STEAM STYLE.

The foremost place among the topical or application styles, *Tafel-Farben* (*German*), belongs to the steam-style, where the colours are developed and fixed on the fibre by the agency of steam. The mordants and colouring matters are in this style mixed together and printed on to the goods in one operation. After this has been done the pieces are taken to the steaming apparatus. In this part of the process great diversity prevails, according to the nature of the colouring-matter used, the effects to be produced, as well as the judgment, and even the caprice of the operator. Sometimes the pieces are steamed as soon as they are printed, whilst in other cases they are previously exposed for some hours to the air. The length of the process differs, from twenty minutes to an hour or upwards. The pressure, and consequently the temperature, also requires attention, and varies from $\frac{1}{2}$ to $1\frac{1}{2}$ atmosphere. A very important point is the degree of moisture. If the steam is too wet the colours are made to penetrate too deeply into the cloth, at the sacrifice of brightness, or may even run. If it is too dry, the colours are in danger of becoming uneven. The volume of steam escaping from the *steam-chest* must be sufficient to carry off any acid vapours, which might otherwise damage the colours themselves, or even the tissue. There is still another difference; in some establishments the pieces are steamed for a short time, say twenty minutes to half an

hour, taken out, exposed to the air, and steamed again; whilst in other works the entire process is completed at once without interruption. On all these points no fixed rules can be laid down, intelligent experience, with a close observation of the results obtained under different conditions, being the only guide.

The steam style has of late years gained additional importance as being the method by which the aniline and other artificial colours are usually applied. This kind of work is not merely very prominent for pure cotton fabrics (calico and muslin), but for mixed tissues of wool and cotton, such as delaines, it may be called universal. Woollens and silks are also printed in this style.

The first step as regards unmixed cotton goods is "preparing." If the shades to be produced are light, the pieces are padded in a solution of the stannate of soda marking 10° Tw. This process is performed in a machine filled with wooden rollers. The goods are then taken out, let remain for an hour without drying, and padded again. They are next taken through vitriol "sours," i.e., dilute sulphuric acid at $1\frac{1}{2}^{\circ}$ to 3° Tw., passed through pure water, and washed. The rolls of pieces are then unstitched, drained in the centrifugal, and dried by steam.

For heavy shades the strength of the preparing liquor and the "sours" is increased. The goods are padded in stannate of soda at about 24° Tw., allowed to remain wet for two hours, and then passed into sours at 6° Tw. They are then washed, drained in the centrifugal, and again treated as above in the same order, drying by steam after the final washing.

In these processes great attention must be paid to keep the sours up to the same degree of acidity. The acid is not merely diluted by the moisture introduced by the wet pieces, but it is in part neutralized by the soda which it takes up. If this point is neglected, the oxide of tin present in the stannate will not be properly deposited on the fibre, and meagre and uneven effects will ensue.

We will now give as specimens some of the mixtures for producing the most important colours:—

Alizarine Red Grounds.

Alizarine at 15 per cent. . . .	27 $\frac{3}{4}$ ozs.
Acetic acid at 8 $\frac{1}{4}$ ° Tw. . . .	35 "
Water	70 "
Olive oil	7 "
Acetate of lime at 14° Tw. . . .	7 "
Wheat starch	17 $\frac{1}{2}$ "

Boil well together, stir till cold, and add:—

Red liquor at 21 $\frac{1}{4}$ Tw. . . .	7 ozs.
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. *Very Heavy Alizarine Red.*

Alizarine for reds at 15 per cent. . . .	7 lbs. 10 $\frac{1}{2}$ ozs.
Thickening	17 $\frac{1}{2}$ pints.
Nitrate of alumina at 21 $\frac{3}{4}$ Tw. . . .	17 ozs.
Red liquor at 17° Tw. . . .	20 $\frac{5}{8}$ "
Acetate of lime at 23 $\frac{1}{2}$ ° Tw. . . .	17 $\frac{1}{2}$ "

Red for Rainbow Styles.

Alizarine at 15 per cent. . . .	5 lbs. 10 $\frac{3}{4}$ ozs.
Thickening for reds	17 $\frac{1}{2}$ pints.
Nitrate of alumina at 21 $\frac{3}{4}$ ° Tw. . . .	10 $\frac{3}{8}$ ozs.
Red liquor at 17° Tw. . . .	20 $\frac{1}{4}$ "
Acetate of lime at 23 $\frac{1}{2}$ ° Tw. . . .	13 $\frac{7}{8}$ "

Another Alizarine Red.

Alizarine at 15 per cent. . . .	2 lbs. 3 ozs.
Thickening	17 $\frac{1}{2}$ lbs.
Red liquor at 17° Tw. . . .	17 $\frac{1}{2}$ ozs.
Acetate of lime at 23 $\frac{1}{2}$ ° Tw. . . .	8 $\frac{3}{4}$ "

This colour may be made suitable for roses by adding to it twice or thrice its own weight of the thickening, according to shade.

The requisites in mixing the above four colours are prepared as follows :—

For the *thickening*, boil well together :—

Wheat starch	13 lbs. 2 ozs.
Water	17½ quarts.
Acetic acid at 8¼° Tw.	7 pints,
Gum tragacanth water (containing 4 ozs. gum per 3½ pints) .	17½ „
Olive oil	3¼ lbs.

For the *nitrate of alumina* mix :—

Nitrate of lead	10 lbs.
Alum (free from iron)	10 „
Water	2 gallons.

Red Liquor.

Stir 33 lbs. of basic sulphate of alumina, free from iron, into 10½ pints acetic acid at 11¼° Tw., and at 77° Fahr. When dissolved, filter and set at the strength required. (N.B. To *set* a liquid at any given strength, means to add water till the required degree is indicated by the hydrometer.)

The sub-sulphate of alumina is obtained by dissolving 79 lbs. alum crystals in 17½ gallons water, and precipitating with 68 lbs. soda crystals previously dissolved in the same quantity of water. The precipitate is washed eight times by decantation, filtered, and pressed.

Acetate of Lime.

A solution of this salt at 23½° Tw. contains 25 per cent. of its weight of the actual acetate of lime.

When a red ground is first printed on, the pieces are steamed for an hour before printing. After printing they are again steamed for an hour, and allowed to air for a day and a night. They are next passed through the following bath at a temperature of 124° to 144° Fahr., each piece occupying from a minute to a minute and a half in traversing the bath.

Water	.	.	.	.	.	875 quarts.
Chalk	.	.	.	.	.	60 lbs.
Tin crystals	.	.	.	.	.	3 „

After this the pieces are washed and submitted to the *clearing* process, which consists of three successive soapings, using per 542 yards:—

1st. Soap 3 lbs., tin crystals $\frac{1}{4}$ lb.; half an hour at 122° F.

2nd. Soap 3 lbs., tin crystals $\frac{1}{4}$ lb.; half an hour at 167° F.

3rd. Soap 3 lbs.; half an hour at 167—178°. The goods are washed between each soaping.

For reds it is necessary to use the so-called “alizarine for reds,” which in addition to alizarine properly so called contains a proportion of anthrapurpurine and flavo-purpurine.

The following instructions for steam reds with artificial alizarine are different in the proportion of the ingredients, and are preferred by some practical men to those given above:—

For Red Grounds.

Alizarine paste, 15 per cent.	.	.	.	.	1 $\frac{1}{2}$ lb.
[Or 10 per cent. paste 2 lbs.]					
Acetic acid at 8 $\frac{1}{4}$ ° Tw.	.	.	.	.	1 quart.
Water	.	.	.	.	2 quarts.
Olive oil	.	.	.	.	$\frac{2}{3}$ lb.
Acetate of lime at 14° Tw.	.	.	.	.	$\frac{2}{3}$ „
Wheat starch	.	.	.	.	1 „

Boil the whole, stir till cold, and then work in—

Red liquor $\frac{2}{3}$ lb.

Steam Colour for Rainbows.

Alizarine paste, 15 per cent. $5\frac{1}{3}$ lb.
 [Or 10 per cent. do. 8 lbs.]
 Thickening for reds (see below) 10 quarts.
 Nitrate of alumina, $21\frac{3}{4}^{\circ}$ Tw. $\frac{3}{4}$ lb.
 Red liquor, 17° Tw. $1\frac{1}{3}$ „
 Acetate of lime, $23\frac{1}{2}^{\circ}$ Tw. $\frac{4}{5}$ „

For Very Deep Reds.

Alizarine paste, 15 per cent. $6\frac{1}{3}$ lbs.
 [Or 10 per cent. do. 10 lbs.]
 Thickening for red 10 quarts.
 Nitrate of alumina, $21\frac{3}{4}^{\circ}$ Tw. $\frac{4}{5}$ lb.
 Red liquor, 17° Tw. $1\frac{1}{3}$ „
 Acetate of lime, $23\frac{1}{2}^{\circ}$ Tw. 1 „

Red without Olive Oil.

Alizarine paste 15 per cent. $5\frac{1}{3}$ lbs.
 [Or 10 per cent. $8\frac{2}{3}$ lbs.]
 Acetic acid, $11\frac{1}{4}^{\circ}$ Tw. $9\frac{1}{3}$ „
 Flour $3\frac{1}{3}$ „
 Water $8\frac{4}{5}$ „

Boil to a paste, stir till cold, and add—

Acetate of lime, $23\frac{1}{2}^{\circ}$ Tw. $15\frac{1}{2}$ ozs.
 Nitrate of alumina, $21\frac{3}{4}^{\circ}$ Tw. 2 lbs.
 Hyposulphite of lime, $12\frac{3}{4}^{\circ}$ Tw. 3 „

Rose and Pink.

Alizarine paste 15 per cent.	3 $\frac{1}{2}$ lbs.
[Or 10 per cent. paste 5 lbs.].	
Thickening for reds	8 quarts.
Red liquor, 17° Tw.	1 lb.
Acetate of lime, 21 $\frac{1}{4}$ ° Tw.	$\frac{1}{2}$ lb.

For a pink add twice or thrice its weight of thickening for reds.

If a dark red design is to be covered on the roller with a lighter red, the dark red is first steamed for an hour. After printing the second colour, it is again steamed for an hour at about $\frac{1}{2}$ atmosphere, and hung up for twenty-four hours. The pieces are then taken through the chalk bath, cleared and raised as already directed.

The thickening for reds above mentioned is prepared with:—

Wheat starch	12 lbs.
Water	5 gallons.
Acetic acid, 8 $\frac{1}{4}$ ° Tw.	1 "
Tragacanth solution (2 ozs. per quart)	10 quarts.
Olive oil, perfectly incorporated with the mass	3 lbs.

Stir till entirely cold.

Or:—

Wheat starch	12 lbs.
Water	17 quarts.
Acetic acid, 8 $\frac{1}{4}$ ° Tw.	17 "
Olive oil	3 lbs.

Alizarine Red on Cotton Warps.

Alizarine paste (for reds) 34 ozs., mucilage of gum

tragacanth $2\frac{1}{2}$ pints, nitrate of alumina at $21\frac{1}{2}^{\circ}$ Tw. $2\frac{3}{4}$ ozs., acetate of lime at $23\frac{1}{2}^{\circ}$ Tw. $3\frac{1}{2}$ ozs. Steam, rinse, and dry.

Alizarine Purples.

Alizarine for purple at 15 per cent.	31 ozs.
Purple thickening	$17\frac{1}{2}$ pints.
Black liquor at 17° Tw.	7 ozs.
Acetate of lime at $23\frac{1}{2}^{\circ}$ Tw.	$12\frac{1}{4}$ "

Purple Thickening.

Starch	11 lbs.
Water	$31\frac{1}{2}$ pints.
Gum tragacanth water, containing 4 ozs. gum per $3\frac{1}{2}$ pints	$15\frac{1}{2}$ "
Olive oil	2 lbs. 3 ozs.

Boil, and stir till cold in the usual manner.

After printing, steam at $\frac{1}{2}$ atmosphere pressure for one to two hours. The pieces are next taken through—

Water	220 gallons.
Chalk	44 lbs.
Arsenate of soda	10 lbs. 15 ozs.

A modification of the above process for alizarine steam purples is:—

Alizarine paste, 15 per cent.	$1\frac{1}{2}$ lb.
[Or 10 per cent. paste $2\frac{1}{4}$ lbs.]	
Thickening for purples (see below)	10 quarts.
Pyrolignite of iron at 17° Tw.	$\frac{2}{3}$ lb.
Acetate of lime, $23\frac{1}{2}^{\circ}$ Tw.	$\frac{3}{4}$ "

The thickening in question is:—

Wheat starch	10 lbs.
Water	18 quarts.
Gum tragacanth solution	9 „
Acetic acid at 11° Tw.	3 „
Olive oil	2 lbs.

This operation takes place at the temperature of 122° to 144° F., in a beck fitted with rollers where the pieces are extended to their full width, and continues from one hour and a half to two hours.

Then follow washing and soaping at 144°—167° F., for half an hour, the proportions being $3\frac{1}{4}$ lbs. soap per 540 yards. The soap used must be exceedingly neutral. That used by the celebrated firm of Thomas Hoyle and Co., of Manchester, consisted of the best curd soap remelted with palm-oil, and to this simple expedient their well-known success in the production of madder-purples was mainly due.

A very slight passage through chloride of lime may be added if needful. As regards the steaming process, the best effect is obtained with well dried pieces, and very wet steam.

Alizarine Brown.

Nitrate of alumina at 27° Tw.	1 lb.
Acetate of lime	$\frac{5}{9}$ „
Red prussiate (dissolved in water)	$\frac{4}{9}$ „
Red liquor at 19° Tw.	$\frac{4}{9}$ „
Thickening	5 quarts.
Alizarine paste at 15 per cent.	$6\frac{2}{3}$ lbs.

Alizarine Chocolate may be produced as follows:—

Alizarine paste, 15 per cent.	2 lbs.
Thickening	10 quarts.
Nitrate of alumina at 27° Tw.	$1\frac{4}{5}$ lb.
Acetate of alumina at 18° Tw.	$\frac{4}{5}$ „
Red prussiate, dissolved in hot water	$\frac{4}{5}$ „
Acetate of lime at 27° Tw.	1 „

This chocolate may be prepared from stale red colours, by adding to them for each quart $\frac{2}{3}$ to 1 oz. red prussiate, dissolved in hot water.

Or:—

Alizarine paste at 15 per cent.	. . .	13 lbs. 2 ozs.
Thickening		17 $\frac{1}{2}$ pints.
Nitrate of alumina at $26\frac{3}{4}^{\circ}$ Tw.		31 ozs.
Red liquor at $18\frac{3}{4}^{\circ}$ Tw.		14 „
Red prussiate of potash (dissolved in water)		14 „
Acetate of lime at $26\frac{3}{4}^{\circ}$ Tw.		17 $\frac{1}{2}$ „

If a yellow cast is wanted, there may be added to each gallon $\frac{1}{4}$ lb. bark liquor at $30\frac{1}{2}^{\circ}$ Tw.

It is generally admitted that the alizarine colours when produced by the steam style are not quite as beautiful as when obtained in the madder style by dyeing upon mordants. The steam process, however, enables alizarine colours to be used in combination with others which would not be practicable by means of the madder style.

ARTIFICIAL BLUES.

Nicholson Blue.

Thicken the dissolved colour with starch, and add from $\frac{1}{8}$ th to $\frac{1}{4}$ th its measure of arsenious acid dissolved to saturation in glycerine, and a corresponding quantity of red liquor. After printing, steam for three-quarters of an hour, and wince in boiling soap-lye to bring up the colour (Calvert).

Aniline Blue.

Pad the pieces in a lye of $\frac{1}{2}$ lb. curd soap per gallon, and dry.

Dissolve $3\frac{1}{2}$ ozs. aniline blue, and add red liquor at 20°

Tw., 35 fluid ozs. bisulphite of soda at $30\frac{1}{2}^{\circ}$ Tw., and the same measure of gum-water (strong) $3\frac{1}{2}$ pints. Steam for ninety minutes, wash, run through soap-lye at a hand-heat and through sours (muriatic), wash, and dry.

Paste Blue.

"Thickening A"	19 $\frac{1}{4}$ ozs.
"Paste blue" (Berlin Anilin Gesell- schaft)	12 $\frac{1}{2}$ "
Glycerine	2 $\frac{1}{2}$ "
Acetic acid at $8\frac{1}{4}^{\circ}$ Tw.	2 $\frac{3}{4}$ "

Print, steam for an hour, wash, and dry. The colour keeps only for a few days.

The "thickening A" is made of red mordant 24 $\frac{1}{4}$ ozs.

(Made up of red liquor at $21\frac{3}{4}^{\circ}$ Tw. 29 $\frac{3}{4}$ ozs., and 3 $\frac{3}{4}$ ozs. wheat starch.)

"Arsenical glycerine B"	5 $\frac{1}{4}$ ozs.
Acetate of lime at $21\frac{3}{4}^{\circ}$ Tw.	$\frac{3}{4}$ "
Tragacanth water	6 "

[containing 8 per cent solid gum.]

The "Arsenical Glycerine B" is prepared from 3 $\frac{1}{4}$ ozs. glycerine at $33\frac{1}{4}^{\circ}$ Tw., evaporated down to 2 $\frac{3}{8}$ ozs., and in it are dissolved at a boil, 1 $\frac{1}{8}$ oz. arsenious acid.

Gentiana Blue (Berlin Aktien Gesellschaft für Anilin-Farben) *Standard Thickening X*:—

Red liquor at $21\frac{3}{4}^{\circ}$ Tw.	105 pints.
Mucilage of gum tragacanth at 8 per cent.	52 $\frac{1}{2}$ "
Starch	22 lbs.
Sulphate of alumina	4 lbs. 6 ozs.

Boil till perfectly incorporated, and when cold add $17\frac{1}{2}$ pints of glycerine arsenic, standard Y.

Glycerine Arsenic, Standard Y.

Glycerine at 45° Tw. 22 lbs., white arsenic 11 lbs. Dissolve at a boil, and let cool.

Mix the blue to shade with thickening X; for a full shade $1\frac{1}{4}$ pint blue, to $8\frac{1}{2}$ pints thickening.

Print, steam for an hour, soap in a weak soap-beck at 165° Fahr., with $3\frac{1}{4}$ lbs soap to 10 pieces calico, and wash.

The "Royal blue" of the same firm is printed in the same manner.

Methylene Blue.

Thickening	$1\frac{1}{4}$ pint.
Solution of methylene blue ($1\frac{1}{8}$ oz. in 35 fluid ozs. water)	7 fluid ozs.
Solution of methyl violet (same strength) $3\frac{1}{2}$ "	
Solution of tannin in water (saturated) $3\frac{1}{2}$ "	

Thickening.

Water	1,000 parts.
Acetic acid at $9\frac{1}{2}^{\circ}$ Tw.	200 "
Tannin	20 "
Gum tragacanth water ($\frac{3}{4}$ oz. per pint).	200 "
Tartaric acid	10 "
Starch	160 "

Boil, and stir till cold.

Print, steam for ninety minutes, pass through solution of tartar emetic at 110° F., and wash very well.

Alizarine Blue.

Thickening	30 ozs.
Alizarine blue	15 "
Acetate of chrome at 14° Tw.	$3\frac{1}{2}$ ozs.

Thickening.

Wheat starch	2 ozs.
Light calcined starch	2 "
Gum tragacanth water	10 "
Castor oil	10 "
Water	20 "

Print, and steam for two hours at the pressure of 1 atmosphere.

GREENS.

Cœruleine Green.

Cœruleine in solution	7 quarts.
Gum water	17½ "
Bisulphite of soda	1¼ pint.

Immediately before using, stir in acetate of chrome at 26¼° Tw. 3½ pints. Print, and steam.

Methyl Green.

Dissolve 3½ ozs. methyl green in warm water at 144° F., avoiding excess. Put 12 ozs. lactarine in a separate vessel, add 8½ ozs. ammonia, and just enough boiling water to dissolve the lactarine. Mix the two solutions, and dissolve in the liquid ¾ oz. picric acid, according to shade.

Thicken with gum water so as to make up 17 pints of colour, print, hang for forty-eight hours in the dark, and rinse.

N.B. This colour cannot be steamed, as at high temperatures methyl green is affected, and turns at 212° F. to a violet. The colour, of course, must not be boiled.

GREYS.

Castelholz Grey.

Gris Castelholz in solution	1 quart.
"Reducing paste"	1 gallon.

To prepare the reducing paste, take :—

Red liquor	4 quarts.
Water	4 quarts.
Starch	3 lbs.

Boil till dissolved, and, when cold, stir in arsenical solution 1 pint.

The arsenical solution is obtained by dissolving 4 lbs. arsenious acid at a boil in 1 gallon glycerine.

Print and steam for half an hour.

Aniline Grey.

Dissolve 1 lb. $5\frac{1}{8}$ ozs. chlorate of potash in 3 quarts boiling water. Let cool, and add :—

Gum-water	$11\frac{1}{4}$ pints.
Sal-ammoniac	$10\frac{7}{8}$ ozs.
Tartaro-chromate of potash at 49°	
Tw.	$3\frac{1}{4}$ lbs.
Aniline	$6\frac{7}{8}$ ozs.
Tartaric acid	2 lbs. $8\frac{1}{2}$ ozs.

Print, age at 105° F. for forty-eight hours, and wash for an hour. For lighter shades, increase the gum. This grey bears all the treatment needful for producing alizarine reds, except the bath of tin salts.

The tartaro-chromate of potash is obtained by dissolving $33\frac{1}{8}$ ozs. bichromate of potash in $5\frac{1}{2}$ pints water at a boil. When it has cooled down to 110° F., add by degrees 3 lbs. $2\frac{1}{8}$ ozs. tartaric acid in fine powder, avoiding rise of temperature.

Aniline Orange.

Colour :—Saturn red (of the Baden Aniline and Soda Company), 9 lbs. 13 ozs.

Glycerine-arsenic	7 fl. ozs.
Water	$2\frac{1}{3}$ pints.
Thickening	14 pints.

The glycerine-arsenic is prepared by dissolving 2 lbs. $8\frac{3}{4}$ ozs. arsenious acid in $17\frac{1}{2}$ pints glycerine at 36° Tw., and concentrating to 100° Tw.

For the thickening dissolve $21\frac{3}{4}$ ozs. gum Senegal in $1\frac{1}{4}$ pint of water (1). Then dissolve separately 13 lbs. 2 ozs. palest blood albumen in 16 pints of water at a very gentle heat; add 7 fluid ozs. caustic ammonia, and $8\frac{1}{2}$ fluid ozs. oil of turpentine (2). To make the thickening, mix $10\frac{1}{2}$ pints of (2) and $3\frac{1}{2}$ pints of (1). Print, dry, steam, and wash.

Nitro-alizarine Orange.

Nitro-alizarine, 15 per cent.	1 gallon.
Acetic acid	2 quarts.
Acetate lime, 28° Tw.	1 lb.
Red liquor, 20° Tw.	1 quart.

Or—

Nitro-alizarine	1 gallon.
Acetic acid	2 quarts.
Acetate lime, 28° Tw.	$2\frac{1}{4}$ ozs.
Nitrate of alumina, 30° Tw.	2 lbs.

For a number of colours, ranging from yellow through orange to red, such as the tropæolines of Williams, Thomas, and Dower, and of Williams Brothers and Ekin; the oranges of Poirrier; the ponceau, G and R, of Meister, Lucius, and Brüning; and, indeed, for the “azo-” colours generally, the following process may be used:—

Prepare the pieces before printing with so-called “alizarine oil.” Then dissolve $3\frac{1}{2}$ ozs. of the colour in $17\frac{1}{2}$ ozs. water. To every pint of the solution, stir well in $\frac{1}{2}$ oz. alizarine oil, and of this mixture add $5\frac{1}{4}$ ozs. to the colouring matter. Thicken as required with starch. Print, dry, steam, steep for an hour in solution of the acetate of lead or of baryta at from 7 to 14° Tw., and wash in cold water. These colours bear light, but not soap.

COAL-TAR REDS.

Magenta.

Take—

Red liquor at 14° Tw.	1 $\frac{3}{4}$ pint.
Arsenite of soda	2 $\frac{3}{4}$ ozs.
Magenta	$\frac{5}{8}$ oz.

Thicken with gum or starch, print, steam for an hour, soap, and wash.

Or, magenta, according to shade, $\frac{1}{2}$ to $\frac{3}{4}$ oz., alcohol 4 ozs.

Boiling water 10 ozs. When dissolved, add oxalic acid $\frac{1}{4}$ oz. Thicken with thick gum water 17 $\frac{1}{2}$ ozs.; add decoction of galls at 11 $\frac{1}{4}$ ° Tw., 18 ozs., and acetic acid 9 ozs. Mix, and stir into the colour-solution, and add further 17 $\frac{1}{2}$ ozs. weak gum-water. This mixture will give a very blue shade.

Saffranine.

Add to 1 pint saffranine paste 10 quarts of the following mixture:—

Red liquor standard	1 gall.
Water	1 gall.
Starch	2 lbs.

Boil, and, when cold, add 1 pint of an arsenic standard, which is obtained by dissolving 1 lb. white arsenic (arsenious acid) in 1 quart glycerine, and filtering.

The red-liquor standard is obtained by dissolving 5 lbs. alum in 2 gallons of water, precipitating with 6 lbs. sugar of lead, and letting settle.

After printing, steam for half an hour.

Eosine.

Prepare well with stannate of soda. Thicken solution

of eosine with gum, add arsenite of alumina, *i.e.*, a mixture of arsenite of soda and red liquor; print, steam, and wash.

Or, prepare with white glue. Thicken solution of eosine with gum, and add three parts of tannin to one of eosine.

Or, prepare with acetate of lead solution to which one-fourth to one-fifth its weight of nitrate of cadmium has been added; dissolve eosine along with soap; thicken with gum, and print on.

Eosine shades, however printed, will not bear soaping.

Red Coralline.

Dissolve—

Coralline	.	.	.	.	.	11 ozs.
Water	.	.	.	.	.	35 „
Glycerine	.	.	.	.	.	8 $\frac{1}{4}$ „

Add magnesia 19 $\frac{1}{4}$ ozs., suspended in 35 ozs. water. Thicken with gum-water 5 $\frac{1}{2}$ pints, containing 3 $\frac{1}{4}$ lbs. gum.

Print, steam, and wash.

A more orange shade may be produced as follows:—Dissolve 4 lbs. 6 ozs. coralline in soda-lye at 14° Tw.; dilute with water, add double muriate of tin, and heat. The precipitate from these quantities is thickened with—

Magnesia	.	.	.	.	.	3 $\frac{1}{2}$ ozs.
Oxalic acid	.	.	.	.	.	9 ozs.
Gum Arabic	.	.	.	.	.	4 lb. 6 ozs.
Water	.	.	.	.	.	17 $\frac{1}{2}$ pints.

Chrysammic Rose.

Gum water	.	.	.	.	.	1 $\frac{1}{4}$ pint.
Chrysammic acid	.	.	.	.	.	30 grains.

This mixture on cloth, prepared with stannate of soda, gives rose shades which bear washing without being steamed. If steamed, the colour passes into a violet.

Azo-Reds.

Dissolve 3 $\frac{1}{2}$ ozs. of the colour in 35 fluid ozs. of boiling

water, and add $17\frac{1}{2}$ pints solution of tin at 22° Tw. Boil to an even paste with $8\frac{1}{4}$ ozs. starch, add $6\frac{1}{8}$ ozs. alizarine oil, and stir in thoroughly. Print, age for twelve hours, and steam.

Prepare pieces before printing by a passage through a mixture of $1\frac{1}{4}$ oz. alizarine oil, and $3\frac{1}{2}$ ozs. ammonia, in $17\frac{1}{2}$ pints water.

ANILINE, ETC., VIOLETS.

Anthracene Violet (Baeyer, of Elberfeld).

Thickening	2 lbs. 3 ozs.
Anthracene violet	7 ozs.
Acetate of chrome at 14° Tw.	$2\frac{1}{2}$ fluid ozs.
Bisulphite of soda at 30.4° Tw.	$4\frac{1}{2}$ „

Thickening.

Water	$5\frac{1}{4}$ fl. ozs.
White starch	$8\frac{3}{4}$ ozs.
Light-coloured starch	1 lb. $1\frac{1}{2}$ oz.
Olive oil	5 ozs.

Steam for ninety minutes, wash, and soap for thirty minutes at 122° — 140° .

If the cloth has been prepared with Turkey red oil, this colour gives a blue.

Galleine Violet.

Gum water	$17\frac{1}{2}$ pints.
Add galleine paste	$17\frac{1}{2}$ quarts.
Acetate of chrome at $26\frac{1}{4}^{\circ}$ Tw.	$1\frac{1}{4}$ pint.

Print and steam.

Hofmann's and Perkins' Violets, &c.

Dissolve $17\frac{1}{2}$ ozs. white tannin in $15\frac{3}{4}$ pints gum water.

Add colour, dissolved and carefully filtered according to shade. Print, and after steaming take the pieces through a bath at 136°—180° Fahr., containing per $1\frac{1}{4}$ quart 1 oz. of the double tartrate of antimony and potash (tartar-emetic). Wash and dry.

This process may be modified as follows :—

The solution of tannin, thickened and ranging from $\frac{3}{4}$ oz. per $1\frac{1}{4}$ pint to $4\frac{1}{2}$ ozs., according as the intended shade is full or heavy, is printed on; the pieces are then steamed, taken through the tartar-emetic bath, washed, and then dyed for twenty minutes in a solution of aniline violet. The liquid is raised gradually to a boil, at which point it is kept for twenty minutes. The pieces are then washed and slightly soaped.

Another process is :—

Add for every 1 oz. of colour, which must be dissolved before using :—

Tannin	3 ozs.
Oxalic acid	$\frac{1}{2}$ oz.

When cold, stir in—

Thick gum water	5 lbs.
Water	36 ozs.
Acetic acid	36 „

Stir in well. Print and steam.

These violets may also be printed by adding red liquor and arsenic glycerine, and thickening with gum and starch. Steam for one hour, and soap carefully.

Neutral Violet (Casella and Co.).

Dissolve 60 parts of colour in 250 parts of acetic acid at 40 per cent. Add 1,000 parts thickening, and when completely cold add 250 parts solution of tannin, stirring constantly.

Thickening.

Water	3,000 parts.
Acetic acid at 40 per cent.	1,000 "
White starch	250 "
Light calcined starch	500 "

Boil together and stir till cold.

Solution of Tannin.

Best white tannin	500 parts.
Hot water	500 "
Acetic acid at 40° per cent.	250 "

Print and steam as usual. It is preferable, though not absolutely necessary, to prepare the cloth in weak alizarine oil and dry before printing. After steaming, the pieces may be taken through a warm solution of tartar-emetic. The shades produced bear soaping.

The same process is suitable for printing the "neutral red" of the same firm, a very dark red.

We now give examples of steam colours produced with the ordinary vegetable and animal colours, for all which the cloth is prepared with stannate of soda, followed by a passage through sours.

Amber.

Gum substitute	15 lbs.
Olive oil (neutral)	7½ fl. ozs.
Bark liquor at 12° Tw.	3 gallons.
Sapan liquor at 8° Tw.	2 pints 5 fl. ozs.
Red liquor at 16° Tw.	3 quarts.

Half boil and add—

Tin crystals	6 ozs.
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Mix till dissolved, and add—

Oxymuriate of tin at 120° Tw.	⅓ pint.
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Mix well and strain as fine as possible. It is necessary in dissolving the tin crystals, that it should be done in a part of the red liquor at the rate of 3 ozs. crystals to the pint of liquor.

Common Black.

Dissolve 5 lbs. $7\frac{1}{4}$ ozs. extract of logwood in water, and let settle. Dissolve separately $17\frac{1}{2}$ ozs. gum tragacanth in water. Mix the two solutions and boil. Extract 2 lbs. 3 ozs. nut-galls in water at a boil, add the clear decoction to the foregoing, and make up to $17\frac{1}{2}$ pints. Let cool, and stir in 2 lbs. 3 ozs. nitrate of iron at 30° Tw., and the same weight of black liquor at 27° Tw. Print, hang up for a few hours, steam, and wash.

Black (for printing along with pigment styles) :—

Logwood liquor at 10° Tw.	. . .	1 gallon.
Catechu liquor at 28° Tw.	. . .	1 pint.
Red liquor at 14° Tw.	. . .	1 „
Acetic acid at 8° Tw.	. . .	1 „
Black liquor at 24° Tw.	. . .	1 „
Starch	. . .	$1\frac{3}{4}$ lb.
British gum	. . .	14 ozs.
Chlorate of potash	. . .	4 „

Boil all together, stir till cold, and add :—

Sal-ammoniac	. . .	4 ozs.
Acetate of chrome	. . .	1 pint.
Sulphate of chrome	. . .	1 „

Mix all well together.

Or (for printing yarns) :—

Extract of logwood at $8\frac{1}{4}^{\circ}$ Tw.	. . .	4 lbs.
Dextrine	. . .	$4\frac{1}{2}$ ozs.
Wheat starch	. . .	$4\frac{1}{2}$ „

Boil, stir till cold, and add—

Black liquor at $39\frac{1}{2}^{\circ}$ Tw. $1\frac{1}{2}$ lb.

Mix well, and print. Air for a day, steam, and rinse.

Or :—

Extract of logwood at $8\frac{1}{4}^{\circ}$ Tw. 4 lbs.

Tragacanth mucilage $\frac{1}{2}$ lb.

Boil, stir till cold, and add :—

Bichromate of potash $4\frac{1}{2}$ ozs.

Blue-stone $2\frac{1}{4}$ „

Mix, print, dry, air for a day, and steam.

Or :—

Boil together :—

Logwood liquor at 8° Tw. 6 gallons.

Starch 2 lbs.

Gum substitute 12 „

Turn off steam, and add :—

Black liquor at 24° Tw. 2 gallons.

Red liquor at 18° Tw. 1 „

mixed together. Then stir in—

Oil 1 pint.

Oil of turpentine $\frac{1}{4}$ „

Another Black.

Logwood decoction at 12° Tw. 6 quarts.

Red liquor at 20° Tw. 3 pints.

Black liquor at 24° Tw. 3 „

Decoction of galls at 9° Tw. 3 „

Acetic acid 3 „

Thicken with:—

Wheat flour	4½ lbs.
Starch	¾ lb.

Boil, and stir in:—

Oil of turpentine	1½ pint.
Gallipoli oil	1½ „

Print, and steam as usual.

Prussian Blue.

Dissolve separately 6¼ ozs. oxalic acid and 12 ozs. yellow prussiate of potash, each in 3½ pints water. Mix, let stand for twenty-four hours, and thicken with 2 lbs. 11 ozs. gum Senegal.

Brown.

Sapan liquor at 6½° Tw.	4 pints 7 fl. ozs.
Logwood liquor at 9½° Tw.	2½ pints.

Thicken with:—

Starch	17½ ozs.
When cold, add tin solution	17½ „

Dark Brown.

Gum starch	6 lbs.
Satin gum	9 lbs.
Olive oil	1 quart.
Red liquor at 17° Tw.	6½ quarts.
Acetic acid at 7° Tw.	6 pints.
Catechu liquor	4 gallons.
Sal-ammoniac	4 lbs.
Sapan liquor at 8° Tw.	1 gallon.
Logwood liquor at 10° Tw.	1 „
Acetate of copper	1 quart.
Nitrate of copper at 86° Tw.	1 „

Boil well, and strain.

Catechu Brown.

Catechu solution	250 parts.
Basic chlorate of chrome	200 "
Water	200 "
White starch	60 "
Dark calcined starch	20 "

After printing, steam for an hour, wash, soap for half an hour at 167° F. with 2 per cent of soap.

Catechu Solution.

100 parts cubic catechu, 50 parts water, 100 parts acetic acid at 9½° Tw.

Or:—

Boil 4 lbs. catechu in water, settle, and strain off the clear. Mix the liquid thus obtained with 1 lb. red liquor at 8° Tw., and thicken with ¾ lb. gum tragacanth. When ready, stir in 1 lb. sulphate of lead.

Chocolate (for printing along with pigments).

Sapan liquor at 8° Tw.	2 gallons.
Bark liquor at 12° Tw.	1½ "
Logwood liquor at 8° Tw.	3¼ "
Red liquor at 18° Tw.	1½ "
Catechu liquor (4 lbs. per gall.)	3 quarts.
Sal-ammoniac	2¼ lbs.
Chlorate of potash	18 ozs.
Red prussiate	9 "
Best starch	10 lbs.

Boil all well together, and stir in:—

Gum tragacanth water	1 gallon.
[½ lb. gum per gallon.]	

Fawn, No. 5.

Catechu liquor at 20° Tw.	2 quarts.
Acetic acid	1 pint.
Logwood liquor at 10° Tw.	3 pints.
Best blue standard (see below)	2½ pints.
British gum	3 lbs.

Fawn, No. 6.

Logwood liquor at 10° Tw.	3 quarts.
Berry liquor at 10° Tw.	3 pints.
Catechu liquor at 20° Tw.	4 „
Cochineal liquor at 6° Tw.	2 „
Oxalic acid	1½ ozs.

Dissolve, and add:—

Iron liquor	½ pint.
British gum	6 lbs.

The “*Best Blue Standard*” above mentioned is made as follows:—

Yellow prussiate	7 lbs.
Alum	2 „
Bisulphate of potash	3 „
Hot water	3 gallons.
Gum water	4 „
Extract of indigo	3 pints.

Pea Green.

Berry liquor at 10° Tw..	3½ pints.
Alum	10 ozs.
Blue standard	5 pints.

Toby Green.

Berry liquor at 20° Tw.	.	.	.	1 $\frac{3}{4}$ pint.
Alum	.	.	.	5 ozs.
Blue standard	.	.	.	5 quarts.
Ground gum dissolved	.	.	.	3 lbs.

Blue Standard for Pea and Toby Greens.

Yellow prussiate	.	.	.	14 lbs.
Alum	.	.	.	6 lbs.
Oxalic acid	.	.	.	3 lbs.
Hot water	.	.	.	6 gallons.
Gum water	.	.	.	2 $\frac{1}{2}$ "
Muriate of tin at 120° Tw.	.	.	.	1 pint.

No. 1 Green.

Berry liquor	.	.	.	1 $\frac{3}{4}$ pint.
Alum	.	.	.	5 ozs.
Ground gum	.	.	.	3 lbs.
Blue standard	.	.	.	6 $\frac{1}{2}$ pints.

No. 2 Green.

The same as No. 1, but the proportion of blue standard is only 6 pints.

Blue Standard for Nos. 1 and 2 Green.

Yellow prussiate	.	.	.	3 lbs.
Alum	.	.	.	14 ozs.
Oxalic acid	.	.	.	7 "
Gum water	.	.	.	15 fl. ozs.
Muriate of tin	.	.	.	3 $\frac{1}{4}$ fl. ozs.

Dark Chrome Green

Guignet's green	66 lbs.
Warm water	5 $\frac{1}{4}$ pints.
Solution of blood albumen	28 "
[9 $\frac{3}{4}$ ozs. per pint.]	
Solution of wax	24 ozs.

Lighter shades of this green are made by letting down the above green with a mixture of—

Gum tragacanth water	3 parts.
[$\frac{7}{8}$ oz. per 1 $\frac{1}{4}$ pint.]	
Solution of blood albumen of the above strength, 1 part.	

Chrome Green (Havranac Shade).

Water	1 $\frac{1}{4}$ pint.
White starch	6 $\frac{1}{4}$ ozs.
Yellow prussiate	8 $\frac{3}{4}$ "
Red prussiate	2 $\frac{1}{8}$ "
Tin pulp	17 $\frac{1}{2}$ "
Chrome alum	8 $\frac{1}{4}$ "

To prepare the tin pulp take:—

Yellow prussiate of potash	2 lbs.
Double muriate of tin at 120° Tw. . . .	1 quart.
Water	3 gallons.

Dissolve the yellow prussiate in half the water, and mix the double muriate with the other. Stir these liquids well together, so as to break up clots, throw upon a filter, and drain. The yield is about 1 gallon.

Chrome Green "Pistachio."

Water	5 $\frac{1}{4}$ pints.
White starch	15 $\frac{1}{2}$ ozs.

Yellow prussiate	13 $\frac{3}{4}$ ozs.
Red prussiate	5 $\frac{1}{8}$ "
Tin pulp	4 $\frac{3}{8}$ "
Chrome alum	8 $\frac{1}{4}$ "
Acetic acid	4 $\frac{3}{8}$ "
Oil	4 $\frac{1}{2}$ "

Another Green.

Starch	2 $\frac{1}{4}$ lbs.
Bark liquor at 16° Tw.	1 $\frac{1}{2}$ gallon.

Boil, and add:—

Alum	9 ozs.
Oxalic acid	1 $\frac{1}{2}$ "
Tin crystals	3 "

When half cold, add:—

Tartaric acid	1 lb. 14 ozs.
Yellow prussiate of potash	3 lbs. 6 ozs.
Tin pulp	1 $\frac{1}{2}$ pint.
Gallipoli oil	$\frac{3}{8}$ pint.

After steaming, run the pieces through chrome liquor at 4 $\frac{1}{2}$ ° Tw.

Wash in clean water, and dry up.

Lavender.

Lavender liquor (see below)	2 quarts.
Blue standard (see below)	2 "
Gum water from	3 to 6 galls.

Lavender liquor is made by adding ground logwood, from 3 to 5 lbs., to 1 gallon of red liquor, at about 18° Tw., steeping for forty-eight hours, and running off the clear liquor through a filter.

The *blue standard* above directed is made of:—

Yellow prussiate of potash	3½ lbs.
Alum	1½ lbs.
Oxalic acid	9 ozs.
Gum-water	2 galls.
Water	2 „

Lilac.

Three measures of the “pink standard” given below are mixed with 1 measure of the “purple standard” (see also below), and thickened with gum-water in quantities which may range from 12 ozs. to 2½ lbs. per gallon of the mixed standards.

Olive.

Extract 2 lb. 3 ozs. berries, and boil down to	5¼ pints.
Sulphate of alumina	3½ ozs.
Copperas	2¼ „
Nitrate of iron	1 „

Thicken with:—

Gum-substitute water	3½ lbs.
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Pink Standard.

Cochineal decoction at 6° Tw.	8 galls.
White tartar	3½ lbs.
Alum	3¼ „
Oxalic acid	14 ozs.

This standard serves as a pink steam colour if thickened with about an equal measure of strong gum-water, more or less, according to shade. Without thickening it is used, e.g., in mixing the lilac colour above mentioned.

Sapan Wood Pink.

Sapan liquor at 4° Tw.	.	.	.	1½ gall.
Sal-ammoniac	.	.	.	¼ lb.
Pink salt	.	.	.	24 ozs.
Oxalic acid	.	.	.	1½ „
Blue-stone	.	.	.	1½ „
Gum-water	.	.	.	1¼ gall.

Pinks are also made of a mixture of cochineal-liquor, and Sapan, or other red-wood liquor, in varying proportions. To 12 gallons of the mixed liquors marking 7° to 8° Tw., are added:—

Alum	.	.	.	6 lbs.
Oxalic acid	.	.	.	¼ „
Nitrate of alumina	.	.	.	1 „
Chlorate of potash	.	.	.	1 „

Thicken with 2 galls. gum-water to 1 gall. of the mixed decoctions.

Purple.

Take equal measures of red liquor at 18° Tw., and of logwood liquor at 10° Tw. In the former dissolve, per gallon:—

Soda crystals	.	.	.	¼ lb.
Oxalic acid	.	.	.	½ lb.

Mix and thicken with 3 lbs. ground gum Senegal per gallon.

Purple Standard.

Logwood liquor at 12° Tw.	.	.	2 galls.
Alum	.	.	1 lb.
Red prussiate of potash	.	.	14 ozs.
Oxalic acid	.	.	2 „
Salt of sorrel	.	.	3 „

This standard may be used as a steam purple printing colour if thickened with 4 to 6 gallons gum-water per gallon.

Another Purple.

Logwood liquor at 16° Tw.	1½ gall.
Red liquor at 20° Tw.	1½ „
Carbonate of soda	1 oz.
Crystal soda	5 „
Red prussiate of potash	¾ lb.
Oxalic acid	¾ „
Gum Senegal	10 „

Boil, cool, and strain.

Cochineal Red.

Gum arabic	3 lbs.
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Dissolve in water, and stir in:—

Oxalic acid	10 ozs.
Tin crystals	10 „

Boil in water in a separate pan:—

Cochineal	1 lb.
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Concentrate the decoction at a steam heat, and add it to the above. Stir in 2½ to 5 ozs. flavine, according to shade. The whole should make up 5¼ pints. Print, dry, steam gently, and wash.

Another Cochineal Red.

Cochineal liquor at 9½° Tw.	64½ pints.
Bark liquor at 30½° Tw.	3½ „
White starch	11 lbs.
Salt of sorrel (i.e. binoxalate of potash)	2 lbs. 3 ozs.

Boil up, stir till cold, and add $3\frac{1}{2}$ pints of the following tin solution:—

Dissolve together 4 lbs. 6 ozs. tin crystals, and 2 lbs. 3 ozs. crystallized stannic chloride. Dissolve separately $17\frac{1}{2}$ ozs. sugar of lead in $1\frac{1}{2}$ pint water. Mix the two solutions, stir, let settle, and use the clear.

Sapan Red.

Sapan liquor at 8° Tw.		4 galls.
Nitrate of alumina		$2\frac{1}{2}$ quarts.
Alum		$2\frac{1}{2}$ lbs.
Quercitron liquor		$2\frac{1}{2}$ quarts.
Chlorate of potash		5 ozs.
Starch		$7\frac{1}{2}$ lbs.

Cochineal Rose.

Cochineal liquor		$1\frac{1}{4}$ pint.
[Containing the colouring matter of $8\frac{1}{2}$ ozs. cochineal.]		
Water		$2\frac{1}{2}$ pints.
Red liquor at 14° Tw.		$17\frac{1}{2}$ fluid ozs
Oxalic acid		$1\frac{1}{8}$ oz.
Thicken with gum		3 lbs. 13 ozs.

Stone Colour.

Add to a lilac or a lavender colour extract of quercitron bark according to shade.

Slate.

Olive oil		1 pint.
Gum starch		10 lbs.

Boil, and add whilst boiling:—

Logwood liquor at 9° Tw.		$1\frac{1}{2}$ gall.
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Iron liquor at 22° Tw.	.	.	.	3 pints.
Red liquor at 18° Tw.	.	.	.	6 quarts.
Acetic acid	.	.	.	$\frac{1}{4}$ pint.

Boil well, and strain.

Cadmium Yellows.

Gum paste	.	.	.	1,000 parts.
Crystallized nitrate of cadmium	.	.	.	150 „
Hyposulphite of soda	.	.	.	150 „

It is well to add a little acetate of soda, and to let the colour stand two or three days before using. Print, and steam.

Cadmium Yellow with Starch.

Water	.	.	.	1,000 parts.
White starch	.	.	.	160 „
Calcined starch	.	.	.	40 „

Boil, and stir till even, and stir in when cold:—

Hyposulphite of soda (cold)	.	.	350 parts.
Nitrate of cadmium (powder)	.	.	350 „

Print and steam.

As the colours mixed with hyposulphite of soda have a tendency to run, it has been proposed to prepare a colour by grinding nitrate of cadmium very long and vigorously with finely divided sulphur. The process is hastened by adding some reducing agent, such as protoxide of tin in a pulp, or, preferably, arsenious acid.

The following mixture is proposed for a full yellow of an orange cast:—

Gum tragacanth water	.	.	1,800 parts.
Nitrate of cadmium	.	.	480 „
Acetate of soda	.	.	800 „
Flowers of sulphur	.	.	250 „
Arsenious acid	.	.	250 „

Strain several times through a hair sieve, and after printing steam for an hour at the pressure of $1\frac{1}{2}$ atmosphere.

It is important to know that an addition of the nitrate of cadmium to ordinary chrome yellows (chromate of lead) prevents the darkening from sulphur-fumes, so often felt as an inconvenience. Thus, to such a yellow, add per $1\frac{1}{4}$ pint of mixed colour from 1 to $1\frac{1}{2}$ oz. nitrate of cadmium, and from $\frac{3}{8}$ to $\frac{3}{4}$ oz. acetate of soda. Such a mixture, when printed, may be exposed to very strong sulphur fumes during steaming without being at all darkened, and the use of back-cloths prepared with sugar of lead may be dispensed with.

Tartar emetic also protects chrome yellows from blackening during the steaming process, but not so perfectly as does the nitrate of cadmium.

Cadmium yellows may also be fixed upon tissues as pigment colours, by grinding the sulphuret of cadmium up with albumen and gum tragacanth, printing, and steaming.

Mixed goods of cotton and wool or worsted, such as delaines, are generally printed on the steam principle with certain modifications. As the first step, the pieces are bleached (stoved) by exposure for some hours to the fumes of burning sulphur in a closed chamber, after which they are well washed. Mr. John Thom has devised an improved stoving machine, instead of the old brick chamber. It is probable, however, that sulphur bleaching in the wet way will be found generally preferable. This is performed by steeping the goods in a concentrated solution of the bisulphite of soda, or preferably of magnesia, to which some muriatic acid has been added, so as to liberate the whole of the sulphurous acid.

The "preparing" with stannate of soda is of even greater importance than in case of unmixed cotton goods. The padding in stannate is generally repeated twice, after which the pieces are taken through vitriol sour at 3° Tw. After washing slightly, and semi-drying, they are then

padded once or twice in a sulpho-muriate of tin—known to dyers as yellow spirits—at about 4° Tw.

A variety of other processes are, however, in occasional use. Instead of the plain stannates, a variety of double stannates, such as the silico-stannates, arsenio and phospho-stannates, alumino and tungsto-stannates have been tried, but without any such marked success as to lead to their general adoption. Others pad the pieces in mixtures of the proto and per-muriates of tin (stannous and stannic chlorides) rendered as neutral as possible.

The sulpho-muriate is made by mixing three measures of double muriate at 120° Tw. with one of oil of vitriol, adding muriatic acid at 32° Tw. equal in bulk, and letting down to the strength required with water.

After padding in sulpho-muriate the pieces pass on without rinsing into a beck of chemic (bleaching lime) at $\frac{1}{2}$ ° Tw. This device, for which printers are indebted to the late Mr. John Mercer, is found to give the colours much more body and brightness than could otherwise be obtained, though the nature of its action is not thoroughly understood. The cloth is then washed, drained in the centrifugal, and dried. Just before printing it is taken through gum-water at about 8 ozs. per gallon.

The following are examples of colours for this class of goods.

The aniline, &c., colours were formerly mixed with egg-albumen for the lightest and most delicate shades, or blood-albumen for darker shades, along with a solution of gum tragacanth, gum-gedda, or the whitest British gum. Thus, for a Hofmann's violet, there was taken from 6 to 24 fluid ozs. of the dissolved violet, with a pint of blood-albumen solution (6 lbs. to the gallon), and $\frac{1}{2}$ gallon of gum-water. The albumen is added after boiling.

This method is now to a very great extent abandoned, and the colours are made up as directed for pure cotton goods, either with arsenite of alumina or with tannin and tartar emetic.

The following very simple process, for $17\frac{1}{2}$ pints of colour, is suitable for many of the coal-tar dyes:—

Gum arabic 2 lbs. 3 ozs., dissolved in water to a uniform mucilage, 1 lb. $1\frac{1}{2}$ oz. calcined wheat starch are well stirred up in water, and heated to a paste in a water or steam-bath. Both are well stirred together, and made up to $17\frac{1}{2}$ pints.

For a violet, the clear solution of 155 grs. methyl, or Hofmann's violet, are incorporated with the above, using more or less colour according to shade.

For a blue, add the clear solution of $\frac{3}{4}$ oz. Nicholson blue, and, finally, the solution of $17\frac{1}{4}$ ozs. alum.

For a red, the solution of $1\frac{3}{4}$ oz. yellowish saffranine.

For a rose, the solution of $\frac{7}{8}$ oz. of bluish saffranine.

For green, the solution of $1\frac{3}{4}$ oz. malachite green, and the clear decoction of $8\frac{1}{2}$ ozs. berries. To the whole, when cold, add $17\frac{1}{2}$ fluid ozs. red liquor at 22° Tw.

For yellow, the clear solution of $\frac{7}{8}$ oz. phosphine or chrysoidine. The whole colour must in no case make up more than $17\frac{1}{2}$ pints after everything is added.

After printing, hang up two days, and steam for two hours at 223° . As a rule they do not require rinsing.

White Designs upon Aniline Colours.

Print the design with the following composition:—

Zinc powder	100 parts.
Gum-water at 30° Tw.	20 „
Hydrosulphite of soda at 39° Tw.	20 „

Let the printing dry; steam, and after steaming, take through very weak muriatic sours to remove the zinc.

The following receipt is given for a saffranine red.

Dissolve 6 parts saffranine in 100 parts boiling water.

Make up a thickening with—

Red liquor at $21\frac{1}{2}^{\circ}$ Tw.	1000 parts
Arsenite of soda at 98° Tw.	500 „
Acetic acid	750 „

Mix and dissolve separately :—

Soda 1,000 parts.

White arsenic 1,000 „

[Dissolved in water, 1,500.]

Mix all together, and add :—

Gum water 1,500 parts.

[Containing gum, 1,000 parts.]

To make up the colour, take—

Solution of saffranine 1 part.

Thickening 5 „

As specimens of the older colours we give :—

Black.

Logwood liquor at 8° Tw. 1 gallon.

Thicken with 1 lb. flour and 1½ lb. British gum.

When cooled down to 98° F., add :—

Nitrate of iron 7½ fl. ozs.

Muriate of iron at 84° Tw.. . . . 7½ „

Nitrate of copper 2 ozs.

Prussiate of potash 4 „

Black for Yarns.

Extract of logwood at 8½° Tw. 8½ lbs.

Dextrine 8½ ozs.

Wheat starch 8½ „

Boil up, stir till cold, and mix with—

Black liquor at 39½° Tw. 3½ lbs.

Stir together.

Print, hang up for a day, steam and wash if needful.

Or :—

Extract of logwood at 8½° Tw. 4½ lbs.

Gum tragacanth 17 ozs.

Boil well together, and stir till cold. Stir in:—

Chromate of potash	8 $\frac{1}{4}$ ozs.
Blue vitriol	4 $\frac{1}{2}$ „

Mix, and print as above.

Another Black.

Logwood liquor at 6° Tw. . . .	7 pints.
Starch	17 $\frac{1}{2}$ ozs.
Dextrine	10 $\frac{1}{4}$ „

Boil, and when half cold add:—

Nitrate of iron at 98° Tw. . . .	8 $\frac{1}{4}$ ozs.
Muriate of iron at 98° Tw.. . .	4 $\frac{1}{2}$ „
Oxalic acid	$\frac{3}{8}$ „

Blue (Prussiate).

Water	1 $\frac{1}{4}$ gallon.
Sal-ammoniac	9 ozs.
Starch	25 „

Boil and stir in:—

Tin pulp	6 quarts.
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When well mixed, add:—

Yellow prussiate	4 lbs.
Red prussiate	2 „
Tartaric acid	6 „
Oxalic acid (dissolved in hot water)	1 $\frac{1}{2}$ „

Dark Blue.

Water	4 gallons.
Starch	16 lbs.
Cochineal liquor at 6° Tw.. . .	1 quart.
Sal-ammoniac	2 lbs.
Tin pulp	4 gallons.

Tartaric acid	16 lbs.
Yellow prussiate	10 "
Red prussiate	6 "
{ Oxalic acid	1 "
{ Hot water	1 quart.

To make the pulp, take:—

Hot water	15 gallons.
Yellow prussiate	28 lbs.

Dissolve, and then add:—

Double muriate of tin at 120° Tw.	6 gallons.
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Stir all very well together, and add:—

Hot water	15 gallons.
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Wash five times in fresh water by decantation, and throw it on a filter to drain.

Sapan Brown.

Sapan liquor at 8° Tw. . . .	2½ pints.
Logwood liquor at 12° Tw. . . .	½ "
Bark liquor at 10° Tw. . . .	5 "
Chlorate of potash	½ oz.
Alum	6 "
British gum	2¼ lbs.

After boiling, stir in:—

Red prussiate of potash	2 ozs.
Oxalic acid	1 "

Chocolate.

Sapan liquor at 8° Tw. . . .	2½ gallons.
Logwood liquor at 10° Tw. . . .	1 "
Bark liquor at 18° Tw. . . .	3 pints.
Red liquor at 16° Tw. . . .	3 quarts.
Starch	9 lbs.

Boil as usual, and add when nearly cold:—

Chlorate of potash	8 ozs.
Red prussiate of potash	4 „
Yellow prussiate of potash	8 „

It is useful to grind the prussiate dry before dissolving, but the chlorate must on no account be ground with it, or a severe explosion may happen.

Cinnamon.

Decoction of quercitron at 20° Tw.	1 gallon.
Ground cochineal	20 ozs.

Let stand for some time in a warm place without boiling, and add:—

Gum Senegal	3½ lbs.
Tin crystals	9 ozs.
Extract of indigo	3 „

Drab.

Decoction of gall-nuts at 12° Tw.	1 quart.
Black liquor at 24° Tw. . . .	5 fl. ozs.
Berry liquor at 10° Tw. . . .	½ pint.
Cochineal decoction at 6° Tw. . . .	5 fl. ozs.
Gum-substitute water	1½ quart.

Green.

Starch	6½ lbs.
British gum	2 „
Bark liquor at 15° Tw. . . .	4 gallons.

Boil, and work in:—

Tin crystals	½ lb.
Alum	2½ „
Tartaric acid	7 „

Yellow prussiate	7 lbs.
Oxalic acid	$\frac{1}{2}$ "
[Previously dissolved in 1 pint hot water.]	
Extract of indigo, about	1 quart.

Regard must be had to the quality of the indigo extract, which varies considerably.

Olive.

Mix a dark green with more or less lavender liquor according to shade.

Pink.

Ammoniacal cochineal liquid at 10°	
Tw.	4 quarts.
Cochineal liquor at 6° Tw.	$\frac{1}{2}$ pint.
Crystallized tartar	2 ozs.
Alum (free from iron)	8 "
Gum	4 lbs.

Purple.

Now chiefly produced by means of the aniline violets.

Orange, red, scarlet, and yellow are now also very generally obtained with the anilines.

For a *Cochineal Scarlet* take:—

Cochineal liquor at 12° Tw.	4 quarts.
Starch	2 lbs.

Boil, and work in:—

Salt of sorrel	2 ozs.
Pink salt	$\frac{1}{4}$ lb.
Tin crystals	$\frac{1}{4}$ "
Oxalic acid	2 ozs.

If a yellower shade be required, a little berry or bark liquor may be added.

After printing, delaines are cooled by hanging up, and

steamed for three-quarters of an hour. They are next winced through water for ten or fifteen minutes, washed in the machine as long as they colour the water, drained in the centrifugal, dried by a steam heat, and hung up for a few days in a cool place.

Both delaines and woollen goods are liable to evolve sulphuretted hydrogen during steaming from an incipient decomposition of the wool, to the great injury of many colours. Hence, it is prudent to wind on the steaming-reels, along with the delaines, pieces of grey cotton cloth previously padded in weak sugar of lead and dried. The lead absorbs the sulphuretted hydrogen and prevents mischief. The same effect may be in many cases produced by adding to the colours a little nitrate of cadmium.

SPIRIT-STYLE.

The spirit-colours, sometimes called pre-eminently application-colours, approach somewhat closely to the steam-colours. Like these they are applied merely to those portions of the cloth where the design is to be actually produced. They are not fixed, however, by steaming, as they contain compounds of tin—technically known as “spirits”—in such proportions that the cloth would be injured if exposed to steam. When printed the pieces are dried, avoiding high temperatures, aged for a short time in the cold, rinsed and washed in cold water, and finally dried. The effects produced are often brilliant, but deficient in permanence.

The spirit-style has relatively decreased in importance in proportion to the growth of the steam-style. It is little adapted for the majority of the new colours, and the colouring matters which it employs are chiefly those of vegetable origin—sapan, logwood, bark and berry liquors. The acid aniline colours, such as acid magenta, might be applied in this style if it should prove convenient.

The following examples will show the nature of the colours used in this style:—

1. *Blue.*

Water	2 gallons.
Starch	2½ lbs.
Yellow prussiate of potash	2 „

Boil till dissolved to a uniform paste, and when cold, add:—

Nitrate of iron at 82° Tw	1½ pint.
Oxymuriate of tin at 100° Tw.	3 pints.

2. *Chocolate.*

Sapan liquor at 8° Tw.	1½ quart.
Bark liquor at 13° Tw.	1 pint.
Logwood liquor at 10° Tw.	1 quart.
Starch	1 lb.

After boiling and cooling down to 110° F., add:—

Oxymuriate of tin at 100° Tw.	½ pint.
Nitrate of copper at 80° Tw.	¼ „
Oil	½ „

3. *Orange.*

Berry liquor at 8° Tw.	1½ quart.
Light British gum	3 lbs.

After boiling, stir in:—

Tin crystals	1½ lb.
Spirit pink (No. 4)	1 gall.

4. *Pink.*

Sapan liquor at 8° Tw.	1 quart.
Salt (common)	8 ozs.

Starch	.	.	.	.	.	6 ozs.
Water.	.	.	.	.	.	1 quart.

After boiling and cooling, work in :—

Oxymuriate of tin at 120° Tw.	.	$\frac{1}{2}$ pint.
Nitrate of copper at 80° Tw.	.	$\frac{3}{4}$ fl. oz.

5. *Pink for blocking in with Madder Work.*

Sapan liquor at 10° Tw.	.	.	.	4 $\frac{1}{2}$ quarts.
Pink salt	.	.	.	2 $\frac{1}{4}$ lbs.
Sal-ammoniac	.	.	.	$\frac{3}{4}$ lb.
Blue-stone	.	.	.	$\frac{1}{2}$ "
Oxalic acid	.	.	.	1 $\frac{1}{8}$ oz.
Water.	.	.	.	$\frac{1}{4}$ pint.
Gum Senegal water (at 6 lbs. per gallon)	.	.	.	4 $\frac{1}{2}$ quarts.
Oxymuriate of tin at 120° Tw.	.	.	.	11 fl. ozs.

6. *Purple.*

Copperas	.	.	.	.	5 ozs.
Starch	.	.	.	.	1 lb.
Water	.	.	.	.	2 quarts.
Logwood liquor at 8° Tw.	.	.	.	.	$\frac{1}{2}$ gallon.

After boiling, stir in :—

Muriate of iron (protochloride of iron or ferrous chloride)	.	$\frac{1}{2}$ pint.
Oxymuriate of tin at 120° Tw.	.	$\frac{1}{2}$ "

7. *Red.*

Starch	.	.	.	.	2 $\frac{1}{4}$ lbs.
Verdigris	.	.	.	.	8 ozs.
Sal-ammoniac	.	.	.	.	8 "
Sapan liquor at 4° Tw.	.	.	.	.	6 quarts.

Boil, and when cold stir in:—

Pink salt	2 $\frac{1}{3}$ lbs.
Oxalic acid	8 ozs.

8. *Yellow.*

Starch	2 lbs.
Alum	1 lb.
Berry liquor at 10° Tw.	2 galls.

Boil, and when cool stir in—

Double muriate at 120° Tw.	1 quart.
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It will be seen that in all these receipts a considerable proportion of tin, generally in the form of a per-salt (stannic salt), is a standing ingredient.

9. *Another Yellow.*

Berry liquor at 5 $\frac{1}{2}$ ° Tw.	21 quarts.
Ground alum	24 ozs.
Solution of tin.	1 $\frac{1}{4}$ pint.
Gum tragacanth	2 lb. 3 oz.

[Previously steeped in 7 quarts of the berry liquor.]

The solution of tin is composed of—

Muriatic acid	19 lbs. 11 ozs.
Tin crystals	13 lbs. 2 „

10. *Violet.*

Logwood liquor at 2° Tw.	1 $\frac{1}{4}$ pint.
Gum-water	9 fl. ozs.

[Containing 8 $\frac{1}{4}$ ozs gum]

Ground alum	1 oz.
Perchloride of tin	1 $\frac{1}{2}$ „
Solution of corrosive sublimate	$\frac{1}{2}$ „

The solution of corrosive sublimate is made up with—

Muriatic acid	.	.	.	.	3½ ozs.
Corrosive sublimate.	.	.	.	.	1¼ „

Twenty-four hours after printing wash well and dry.

PIGMENT STYLE.

The pigment style is one which has been remarkably developed of late years, and which adds greatly to the resources of the printer, serving to produce effects which would otherwise be impracticable. In all the other styles of printing, as well as in dyeing, the colouring matters are soluble, and are rendered insoluble upon the fibre. In the pigment style the colours are insoluble colours in exceedingly fine powder. This is ground up with some suitable medium, printed, and then steamed and dried. By the steaming process the medium is coagulated and rendered insoluble, and the colour is consequently left permanently deposited upon the fibre. The colours adapted for this style are the lakes, including carmine, vermilion, ultramarine of different shades, chrome yellows, and oranges—i.e., chromates and dichromates of lead, cadmium-yellow (sulphuret of cadmium), Guignet's green, and other chrome greens, carbonaceous grey, lamp black, the umbers, ochres, and other natural coloured earths, which must be previously brought to the highest degree of fineness by elutriation.

The principal mediums used are albumen, as obtained from blood or eggs. This is ground up into a uniform paste with the colour, thickened with mucilage of gum-tragacanth, and after printing, fastened by steaming.

Casein, or as it is commonly called in print-works lactarine (from the very unscientific name given it by a patentee) is also used. It is dissolved in ammonia, and becomes fixed as the solvent is volatilized by heat. Vege-

table gluten is also occasionally used. Where cost is less the object than excellence, albumen should always be preferred. Various varnishes and oily mixtures, solutions of india-rubber, &c., have been tried as mediums for pigments, but so far without any very general success. Here, consequently, there is decided room for improvement. One proposal is to incorporate the colour with collodion,—i.e., a solution of pyroxiline in a mixture of alcohol and ether. The high price of ether and the inflammable character of its vapour present difficulties in working this process on the large scale.

The pigment style is chiefly adapted to the smaller features of a design, dots, stars, flowers, fine lines, &c. We rarely meet with goods printed exclusively by this process, but it serves to embellish or illuminate designs mainly produced by other styles. Pigment colours are often applied by the block, or as it is technically called "blocked in," after the other parts of the design have been completed. They take a high place as regards solidity and permanence, and as now produced they are free from the chalkiness and opacity which was complained of some years ago.

The following medium has been proposed by Schlumberger for fastening the pigment colours:—1,000 parts casein, 75 parts calcined magnesia, and 4,800 parts water are taken, each of the solids is separately worked up with portions of the water, and the whole is mixed together and allowed to stand for a few hours, when it forms a thick pasty mass. Three hundred parts of hydrated baryta (barium hydroxide) are next dissolved in ten times their weight of warm water, and stirred into the casein paste. The pigments are then ground up with this mixture.

The following are processes for pigment blues applicable to silk or cotton:—

(a.)

Albumen solution	1 quart.
Finest ultramarine	22½ ozs.

(b.)

Of the mixture above	.	.	.	1 quart.
Water	.	.	.	4 quarts.
Zinc white	.	.	.	2½ lbs.
Solution of albumen.	.	.	.	1 gallon.
Ammonia soap (liquid)	.	.	.	1 pint.

For the solution of albumen take:—

Best blood-albumen	.	.	.	26 ozs.
Water at 88° F.	.	.	.	1½ quart.
Ammonia soap	.	.	.	1 pint.

For the ammonia soap mix:—

Soft soap	.	.	.	1½ lb.
Warm water	.	.	.	½ gall.

Dissolve and stir in:—

Oil of turpentine	.	.	.	1 lb.
Ammonia	.	.	.	1 lb.

Or:—

Make up the ultramarine to a paste with glycerine, grinding it well up in a paint-mill and running it through three strainers.

For the paste take:—

Ultramarine	.	.	.	7 lbs.
Glycerine	.	.	.	3½ „

For the colour:—

Paste as above	.	.	.	4 lbs.
Solution of albumen	.	.	.	2½ „

After printing, steam, take through boiling water, and wash.

Trouble is often experienced in pigment styles, and indeed in all colours containing insoluble matter, if applied with the machine, by the “sticking on” or “sticking in” of the colour. That is, the colour, instead of being evenly and uniformly taken up by the calico from the engraving

on the cylinder remains in part adhering to the latter, until the engraving is filled up. The colour is in a manner unmixed, or mechanically decomposed in this process. The soluble ingredients are delivered in the usual manner upon the piece which is being printed, whilst the insoluble ingredients—which in pigment styles are the most important—remain on the engraved roller.

The only remedy for this evil is greater care in the perfect mixture of all colours in which insoluble ingredients are present.

In block printing this inconvenience does not make itself felt.

ANILINE BLACK AND ALLIED STYLES.

Aniline blacks, though they are in some cases fastened by steaming, and though they can be combined with almost every style, are most conveniently treated of separately.

1. *Ungreenable Aniline Black with Vanadium.*

Water	.	.	.	.	550 parts.
White starch	.	.	.	.	125 „
Dark calcined starch	.	.	.	.	42 „

Boil, and when cooled down to 122° F., add:—

New aniline oil	.	.	.	.	80 parts.
Muriatic acid at 32° Tw.	.	.	.	.	80 „

When perfectly cold, add:—

Chlorate of soda	.	.	.	.	42 parts.
Boiling water	.	.	.	.	50 „

Just before using, stir in:—

Solution of vanadium (see below). 20 parts.

Age for two days; take through bichromate of potash 75 grains to 1¼ pint of water, at 158° F., wash, and soap.

Instead of using the respective proportions of aniline and muriatic acid mentioned above, it is better to neutralize the aniline exactly with the necessary amount of muriatic acid, using methyl violet as an indicator. To the aniline oil muriatic acid is added till a few drops of the liquid, added to a very dilute solution of methyl violet in water, turn it to a greenish blue. The air of the ageing room should be very moist, and a little sal-ammoniac, say 10 parts, may be usefully added to the colour in order to attract moisture.

To prepare the solution of vanadium: Dissolve 155 grains vanadate of ammonia in $1\frac{1}{4}$ oz. muriatic acid, previously diluted with an equal measure of water, heating the whole gently in a porcelain crucible, and adding by degrees small quantities of glycerine, stirring briskly till the liquid has become a dark green, and all undissolved matter has disappeared. Then dilute with 17 pints of water. The liquid turns a light blue and is preserved in a closed bottle; $3\frac{1}{2}$ ozs. of this solution suffice for 22 lbs. of colour.

2. *Copper Aniline Black.*

Water	.	.	.	.	.	1 gall.
Muriate of aniline	.	.	.	.	.	2 lbs.
Aniline oil	.	.	.	.	.	2 ozs.
Starch	.	.	.	.	.	2 lbs.
British gum	.	.	.	.	.	8 ozs.

Boil and cool.

Chlorate of soda solution 12° Tw.	.	.	.	.	.	1 gall.
White starch	.	.	.	.	.	2 lbs.
British gum	.	.	.	.	.	$\frac{1}{2}$ "
Ammonium chloride	.	.	.	.	.	$\frac{1}{2}$ "

Boil and cool.

When ready for printing, mix the two together, and add 1 pint of copper paste and strain when the colour is ready.

This black can be fixed either by ageing or steaming. If the latter method is preferred steam for half an hour at a pressure of 3 to 4 lbs., roll the pieces in bundles, let lie over-night, and soap in morning.

3. *Cordillott's Aniline Black.*

White starch	.	.	.	.	13 $\frac{3}{4}$ ozs.
Light calcined starch	.	.	.	.	6 $\frac{3}{4}$ „
Lamp-black	.	.	.	.	$\frac{3}{4}$ „
Water.	.	.	.	.	4 lbs. 6 „
Aniline oil	.	.	.	.	14 $\frac{1}{2}$ „

Boil well, and add:—

Chlorate of baryta	.	.	.	.	9 $\frac{1}{2}$ ozs.
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Add by degrees:—

Tartaric acid	.	.	.	.	19 $\frac{1}{4}$ ozs.
Dissolved in water	.	.	.	.	35 „

Stir up, and add:—

Red prussiate of ammonia	.	.	.	.	27 $\frac{1}{2}$ ozs.
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To prepare the red prussiate of ammonia, dissolve 12 $\frac{1}{4}$ ozs. sulphate of ammonia in 13 $\frac{3}{4}$ ozs. boiling water, and add to it the solution of 2 $\frac{1}{4}$ lbs. red prussiate of potash in 4 lbs. 8 $\frac{3}{4}$ ozs. boiling water. Mix the two liquids, let stand for two days that the sulphate of potash may crystallize out, and draw off the clear for use.

This black bears steaming immediately, it does not tender the cloth and can be associated, with all colours. It is, however, costly.

4. *Cerium Aniline Black.*

White starch	.	.	.	.	30 lbs. 10 ozs.
Light calcined starch	.	.	.	.	14 $\frac{1}{4}$ lbs.
Water	.	.	.	.	242 „

Sal-ammoniac . . .	3 lbs. 14 ozs.
Chlorate of potash . .	6 lbs. 12½ ozs.
Muriate of aniline . .	13 lbs. 7½ ozs.

To 220 lbs. of the solution are taken 49½ fluid ozs. of cerium solution. The colour is developed in about eight hours, and is remarkably rich and deep, with a blue reflection.

The cerium solution is prepared by treating cerite with sulphuric acid. The mass is then lixiviated with water, and the liquid is filtered to remove silica, and is then concentrated for use. The cerite is ground very fine and is heated with an equal weight of oil of vitriol in a leaden pan. 1 lb. cerite yields about 9 lbs. solution.

5. *Chlorate of Ammonia.*

Water, 157 fluid ozs. ; liquid ammonia, 7 pints, sp. gr. 0·9.

Mix, and add 157 fluid ozs. water in which have been dissolved 4 lbs. 6 ozs. tartaric acid. Then add: Boiling water 43½ pints, chlorate of potash 9 lbs. 10 ozs.

Stir till all is dissolved. The mixture should be neutral to test paper. Then put in tartaric acid as above, 157 fluid ozs., stir continually for a quarter of an hour, and afterwards at intervals throughout the day while the mixture is cooling. When quite cold, throw on a filter and wash in the filter with 11½ pints of water, adding the washings to the filtrate. The yield is 74 pints at sp. gr. 1·05.

Thickening No. 1.

Chlorate of ammonia solution, as above, 63 pints; starch, 17 lbs. 13 ozs. Heat to 155° F., incorporating thoroughly, and cool.

Thickening No. 2.

Chlorate of ammonia solution, as above, 1103 fluid ozs. ; brown British gum, 39 lbs. 10 ozs. Heat also to 155° F., and cool. Equal quantities of these two thickenings are made ready for use.

Colour.

Mixed thickenings, 63 pints; muriate of aniline, at spec. grav. 1.10, 315 fluid ozs.; sulphuret of copper paste, $77\frac{1}{2}$ fluid ozs. These mixtures should be prepared in stoneware pans, heated in the water-bath, or in enamelled iron pans fitted with steam-jackets.

Sulphuret of Copper Paste.

Caustic soda, at sp. gr. 1.35, 315 fluid ozs.; flowers of sulphur, 4 lbs. 14 ozs. This is put in stoneware vessels and frequently stirred with an iron ladle till all is dissolved, which may take from twenty-four to thirty hours.

Add this all at once to 23 lbs. 13 ozs. blue-stone, dissolved in 472 pints boiling water, stir well, and make up with cold water to 787 pints. Let settle, run off clear liquid, and wash three times by decantation, and drain upon a filter. The yield is about 21 pints of paste.

Muriate of Aniline Solution.

Aniline oil	.	.	.	.	.	63 pints.
Muriatic acid (33° Tw.)	.	.	.	.	.	$50\frac{3}{4}$ pints.
Water	.	.	.	.	.	27 "

The yield is nearly 140 pints at sp. gr. 1.00.

Or take—

Muriate of aniline crystals	.	.	.	.	.	89 lbs. 11 oz.
Aniline oil	.	.	.	.	.	9 " 13 "
Water	.	.	.	.	.	3 lbs.

Instead of chlorate of ammonia, chlorate of soda and chlorate of baryta may be used, by substituting caustic soda or baryta for ammonia. In these cases it is less essential to avoid the use of copper pans.

Aniline Black, No. 5.

Dissolve in 22 gallons cold water starch paste, 110 lbs.; chlorate of potash, 6 lbs. 9 ozs.; sal-ammoniac, 5 lbs. 7 ozs.; and mix in sulphuret of copper paste, 10 lbs. 15 ozs. Before using, add starch paste, 110 lbs.; liquid muriate of aniline, 66 lbs. (50 parts muriatic acid and 46 parts aniline oil). Print and age the moist goods. The colour comes up a dark green. If the shade is not full enough, age longer.

Lastly, take through a weak beck of carbonate of soda and chromate of potash.

6. New Aniline Black.

Water	25 ozs.
Starch	30 „

Tungstate of chromic oxide (paste), 24 ozs. Boil well together, and when the mixture has cooled down to about 90° F., add :—

Chlorate of potash	7 ozs.
Sal-ammoniac	3½ „
Muriate of aniline	28 „

Aniline Black (Dreyfus's).

Chlorate of ammonia	7½ quarts.
Starch	3 to 4 lbs.
British gum	3 to 4 „

Boil well together, and let cool; then add :—

Muriate of aniline, neutral (2 lbs. per quart)	3½ pints.
Sulphuret of copper	½ pint.

Aniline Oxalate Black.

Chlorate of potash	4 ozs.
Chloride of calcium	8 „

Starch paste	2 quarts.
Gum tragacanth mucilage	2 „
Light gum-water	2 „

Boil well together, let cool, and stir in:—

Oxalate of aniline	12 ozs.
Sal-ammoniac	1½ oz.
Sulphuret copper	4½ ozs.

Aniline Black, with Sulphocyanide of Copper.

Water	2 quarts.
Starch	8 ozs.
British gum, dark	8 „
Sulphocyanide of copper (paste)	1 oz.

Boil, and stir in—

Chlorate of potash.	4 ozs.
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When cool, add—

Muriate of aniline	8 ozs.
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Koechlin's Aniline Black, with Tartaric Acid.

Water	4½ quarts.
Aniline oil	4½ „
Starch	10 lbs.
British gum, dark	10 lbs.

Stir well together, and add—

{ Chlorate of potash	5½ lbs.
{ Sal-ammoniac	5½ „

Dissolved in—

Water	4 gallons.
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Boil, cool, and add—

Sulphuret of copper paste	2 quarts.
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Just before printing add—

Tartaric acid	22 ozs.
dissolved in	
Hot water	1 pint
per gallon of the colour.	

Pinkney's Aniline Black.

Muriate of aniline	150 parts.
Salt of vanadium	18½ „
Chloride of nickel	20 „
Chlorate of potash	100 to 150 „
Gum-water	1,200 „

The chief importance of this specification is that it recalled attention to the use of vanadium in the production of aniline black, which though noted by Lightfoot had been overlooked.

Resists for Aniline Black.

White designs on aniline black grounds may be obtained by printing on the following reserve-paste:—

White arsenic	10½ lbs.
Soda-lye, at 65° Tw.	7 pints.
Water	7 „

Dissolve with the aid of heat, and when cold let down with cold water to 141½° Tw. Of the clear solution, 5½ pints are diluted with 15½ pints water, and thickened with 11 lbs. dextrine.

Where this compound is printed the aniline black is not formed.

Or:—

Sulpho-cyanide of potassium	760 grains.
Gum-water	1½ pint.

Print on, steam, and print the aniline black over it. In case of an acid colour, the sulpho-cyanide of lead is used.

Discharge for Aniline Blacks.

Make an acid solution of permanganate of potash, thicken with finest China-clay and siliceous earth, well ground and elutriated. Block in dry, and pass the pieces through oxalic acid. No starch, gum, or other organic matter must be used for thickening.

Cerium Aniline Grey.

White starch	18 lbs. 12 $\frac{3}{4}$ ozs.
Light calcined starch	4 lbs. 2 ozs.
Water	132 lbs.
Sal-ammoniac	1 lb. 1 $\frac{1}{4}$ oz.
Muriate of aniline	1 lb. 1 $\frac{1}{4}$ oz.
Muriatic acid	1 lb. 1 $\frac{1}{4}$ oz.
Cerite solution	5 $\frac{1}{2}$ ozs.

Age for a few hours in a warm room, and soap well. It may be printed along with steam colours.

Ordinary Aniline Grey.

Dissolve 21 $\frac{1}{2}$ ozs. chlorate of potash in 6 pints boiling water. When cold add:—

Gum-water	11 $\frac{1}{2}$ pints.
Sal-ammoniac	10 $\frac{3}{4}$ ozs.
Chromo-tartrate of potash at 49° Tw.	3 $\frac{1}{4}$ lb.
Aniline	6 $\frac{7}{8}$ ozs.
Tartaric acid	2 $\frac{1}{2}$ lbs.

To prepare the chromo-tartrate of potash, dissolve 33 $\frac{1}{2}$ ozs. bichromate in 105 fluid ozs. hot water. When it has cooled down to 111° F., add gradually 3 lbs. 2 ozs. tartaric acid in powder, avoiding a rise of temperature.

Print, age for 48 hours at 89° F., and wash for an hour. For lighter shades, increase the gum. This grey bears all the processes necessary for alizarine reds, except passage through a salt of tin.

The following colours produced with an induline can be introduced here:—

Black.

White starch	4 lbs.
Water	5 $\frac{1}{4}$ quarts.
Indigo substitute (Geigy's)	4 $\frac{1}{4}$ „
Gum tragacanth water	1 „
Turkey red oil	$\frac{1}{2}$ pint.
Berry liquor at 30 $\frac{1}{2}$ ° Tw.	2 $\frac{1}{16}$ quarts.

Boil, and add when cold:—

Acetate of chrome, at 20° Tw.	6 pints.
Bisulphite of soda, at 41° Tw.	1 pint.

Olive.

White starch	8 lbs.
Water	10 $\frac{1}{2}$ quarts.
Indigo substitute	4 $\frac{1}{4}$ „
Gum tragacanth water	2 $\frac{1}{16}$ „
Turkey red oil	$\frac{1}{2}$ pint.
Acetic acid	2 $\frac{1}{16}$ quarts.
Berry liquor, at 30 $\frac{1}{2}$ ° Tw.	3 $\frac{1}{2}$ „

Boil, and when cold add—

Acetate of chrome, at 20° Tw.	1 quart.
Bisulphite of soda, at 41° Tw.	1 pint.

Blue.

White starch	6 lbs.
Water	25 pints.
Indigo substitute	2 $\frac{1}{16}$ quarts.

Gum tragacanth water . . .	$2\frac{1}{10}$ quarts.
Acetic acid	$2\frac{1}{10}$ "
Turkey red oil	$\frac{1}{2}$ pint.

Boil, and add when cold :—

Acetate of chrome, at 20° Tw. . .	1 quart.
Bisulphite of soda, at 41° Tw. . .	1 "

Naphthylamine Puce.

Nitrate of naphthylamine . . .	2 lbs. $12\frac{3}{4}$ ozs.
Acetic acid at 11 $\frac{1}{4}$ ° Tw.. . . .	33 ozs.

Dissolve and add :—

Lukewarm starch paste (at 5 $\frac{1}{4}$ ozs. starch for 35 fluid ozs.) . . .	7 pints.
{ Chlorate of potash	$2\frac{1}{2}$ ozs.
{ Dissolved in hot water	26 "

At the moment of using about $2\frac{3}{4}$ ozs. hydrofluosilicic acid is added. Print with the cylinder, and age for twenty-four hours at 76° F. with the wet-bulb thermometer at 78° F.

To prevent the naphthylamine salt from crystallizing out during printing, the cylinder is kept hot by turning in a trough of boiling water, and the colour itself may be kept at about 100° to 110° by a water-bath.

After ageing, the pieces are taken through a cistern fitted with rollers, and containing per 35 ozs. cold water $2\frac{1}{2}$ ozs. bichromate of potash, and $1\frac{1}{4}$ oz. muriatic acid at 33° to 34° Tw.

On leaving this bath the pieces fall into cold water, and are washed in the machine. They are then passed by eight at a time into a beck containing 153 gallons of cold water, and 7 quarts alkaline chloride of soda, at 21 $\frac{1}{2}$ ° Tw. They are winced here for twenty minutes and passed into soap-lye at 30 grains per 35 ozs. cold water for half an hour, cleaned and dried.

Naphthylamine Yellowish Grey.

Water	1 gallon.
Starch	80 ozs.
Naphthylamine	8 "
Chlorate of potash	2 $\frac{1}{2}$ "
Sal-ammoniac	1 $\frac{1}{2}$ "
Acetic acid	$\frac{1}{2}$ lb.
Muriatic acid	2 ozs.
Muriate of iron, 75° Tw.	4 "

Reduce, if desired, with starch paste.

Naphthylamine Grey.

Yellowish grey, as above	3 pints.
Starch paste	1 pint.
Aniline grey	1 "

The starch paste referred to is prepared with:—

Starch	20 ozs.
Acetic acid	8 ozs.
Water	1 gallon.

Boil, and stir in 1 $\frac{1}{2}$ oz. olive oil.

Aniline Grey (Rhem's).

Gum tragacanth water	12 pints.
Chlorate of potash	6 ozs.
Sal-ammoniac	6 "
Muriate of aniline	$\frac{3}{4}$ "
Nitrate of copper, 84° Tw.	5 "
Muriatic acid	6 "

(The last three colours are not remarkable for beauty.)

Naphthylamine Grey, No. 1 (Lamy's).

Starch paste	8 quarts.
Muriate of iron crystals	1 lb.
Previously dissolved in—	
Water	2 quarts.
Naphthylamine chocolate	$\frac{4}{5}$ pint.

Do. No. 2.

As No. 1, but 1 lb. crystals of chloride of copper in place of muriate of iron.

The chocolate above mentioned is thus made :—

Nitrate of naphthylamine 3 lbs. 3 ozs.

Dissolve in—

Acetic acid, 11° Tw.	1 quart.
Starch paste, warm	1 gallon.
[Containing 24 ozs. starch.]	

Lastly, add :—

Chlorate of potash	$2\frac{3}{4}$ ozs.
In boiling water	1 pint.

COMPOUND DESIGNS.

The following few examples will throw a light on the methods of producing designs in a variety of colours.

1. *Rose, Grey, and Black on Calico (Steam Style).**Rose.*

Solution of carmine	70 fluid ozs.
Palest blood-albumen thickening	175 „

Gum-water	52 quarts.
[17 $\frac{1}{4}$ ozs. gum to 1 $\frac{1}{4}$ pint.]	
Water	70 fl. ozs.

To make the solution of carmine, take—

Carmine	13 lbs. 2 ozs.
Ammonia (at sp. gr. 0.968)	8 $\frac{1}{4}$ lbs.

Grey.

Lamp-black paste	5 lbs. 7 $\frac{1}{4}$ ozs.
Residue of ultramarine blue	1 $\frac{1}{4}$ pint.
Dark blood-albumen thickening . . .	19 $\frac{1}{4}$ „
Gum-water	12 $\frac{1}{4}$ „

Lamp-black paste is thus made:—

Lamp-black	5 lbs. 7 $\frac{1}{4}$ ozs.
Oil of vitriol	21 „ 14 „

Stir together, and let stand for twelve hours; wash with water till acid is removed, and use the moist paste.

Black.

Logwood liquor, at 11 $\frac{1}{4}$ ° Tw. . . .	122 pints.
Water	52 „
Chlorate of potash	3 lbs. 11 $\frac{1}{4}$ ozs.
Olive oil	52 fl. ozs.
Wheat starch	32 lbs. 13 ozs.
Dextrine	58 $\frac{1}{4}$ lbs.

To every 22 lbs. of this mixture add 2 lbs. 3 ozs. of the following mordant:—

Solution of chrome at 43° Tw. . . .	17 $\frac{1}{4}$ pints.
Caustic soda at 72° Tw.	1 $\frac{1}{4}$ „
Acetate of chrome at 18 $\frac{1}{4}$ ° Tw. . . .	14 „

For the chrome solution dissolve 12 lbs. chrome alum in 13 pints water, and filter.

For the acetate of chrome solution, take of the above solution of chrome alum $1\frac{3}{4}$ pint, and sugar of lead 21 ozs. Dissolve, settle, decant the clear, and set at $18\frac{1}{2}^{\circ}$ Tw.

Puce, Red, Rose (fast) with Green, Yellow, Violet, and Blue (Steam).

The pieces, perfectly bleached, are printed with the following colours with the cylinder machine:—Discharge red, P.S.; rose, 1. 8. Z 5 and 6; puce, B 2.

Discharge Red, P. S.

Red liquor at 20° Tw. . . .	$17\frac{1}{2}$ pints.
Sapan liquor, at $30\frac{1}{2}^{\circ}$ Tw. . . .	$17\frac{1}{2}$ ozs.
White starch	4 lbs. 6 ozs.
Calcined starch	$8\frac{3}{4}$ lbs.
Oil of turpentine	$3\frac{1}{2}$ ozs.
Tin crystals	$2\frac{1}{4}$ „

Boil and stir till cold.

Rose, 1. 8. Z. 5.

Red liquor, at $15\frac{1}{2}^{\circ}$ Tw. . . .	$1\frac{1}{4}$ pint.
Dextrine water	14 „

To every $1\frac{1}{4}$ pint of this mixture, add $2\frac{5}{8}$ ozs. tin crystals.

To make the red liquor aforesaid take:—

Water	175 pints.
Alum and sugar of lead, each . .	109 lbs. 6 ozs.

The dextrine water is made by dissolving at a boil $48\frac{3}{4}$ lbs. calcined starch in $52\frac{1}{2}$ pints of water.

6 Puce, B. 2.

Red liquor, set at $8\frac{1}{2}^{\circ}$ Tw. . . .	$17\frac{1}{2}$ pints.
Black liquor, at $8\frac{1}{2}^{\circ}$ Tw. . . .	35 „

Extract of logwood, at 30° Tw.	10½ ozs.
White starch	13 lbs. 2 ozs.
Calcined starch	3½ lbs.
Oil	1½ oz.

After printing age for twelve hours, and dung for four minutes at 176° F., in the following mixture:—

Forty-four gallons dung, and 10½ pints arseniate of soda and potash. This solution is made by dissolving 105 lbs. bi-arsenate of potash in 175 pints of boiling water, and neutralizing with 262 pints caustic soda, at 30½° Tw. This yields 210 pints liquid at 71° Tw.

For every ten pieces add to the dung-beck 17½ ozs. weight of cow-dung stirred up in water, and 8½ ozs. measure of the arsenical solution. Wash in the machine, dung again for half an hour at 167° Tw., and wash once in the wheel and twice in the machine. A third dunging is done at the same heat for half an hour, and the pieces are washed once in the wheel and twice in the machine.

Dye per 109 yards with 19 ozs. alizarine at 10 per cent.

Enter at 98° F., raise to 143°, and take swatches to judge of the saturation.

Wash in the machine, take through a bran-beck at 167° F. Dry in a current of air, calender lightly, and block in the following colours:—

3 Steam-green, yellow M, light and dark violets, and ultramarine blue. Finally steam, wash, and finish.

3 Steam-green.

Berry liquor at 8¼° Tw.	5¼ pints.
Boiling water	8¼ "
Gum-water at 69° Tw.	7 "
Yellow prussiate	2 lbs. 3 ozs.
Oxalic acid	7 ozs.
Alum	14 "
Acetic acid at 11¼° Tw.	14¼ "
Permuriate of tin at 113° Tw.	8½ "

Yellow M.

Berry liquor at $8\frac{1}{4}^{\circ}$ Tw.	.	.	.	3 $\frac{1}{2}$ pints.
Water	.	.	.	17 $\frac{1}{2}$ fl. ozs.
Pink salt	.	.	.	5 $\frac{1}{4}$ ozs.
Oxalic acid	.	.	.	1 $\frac{1}{8}$ „
Powdered gum	.	.	.	2 lbs. 11 $\frac{3}{4}$ ozs.

The violets (methyl) and the ultramarine are mixed in the ordinary manner.

*Blue, Yellow, Green, and Black (Steam) on Half Silks.**Blue.*

Gum tragacanth	.	.	.	17 $\frac{1}{2}$ ozs.
White glue	.	.	.	4 $\frac{1}{2}$ „
Water.	.	.	.	17 $\frac{1}{2}$ pints.

Boil together, and in the liquid dissolve:—

Soluble aniline blue	.	.	.	1 $\frac{1}{8}$ oz.
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Boil up again, cool, and strain.

Yellow.

Boil up 10 $\frac{1}{8}$ ozs. berry liquor at $6\frac{1}{2}^{\circ}$ Tw. with 17 $\frac{1}{4}$ ozs. gum tragacanth in 17 $\frac{1}{2}$ pints water.

Stir till cold, and add:—

Tin salt	.	.	.	3 $\frac{1}{4}$ ozs.
Oxalic acid	.	.	.	8 $\frac{3}{4}$ „

Black.

French extract of logwood	.	.	.	2 lbs. 3 ozs.
French extract of fustic	.	.	.	4 $\frac{1}{2}$ „
Gum tragacanth	.	.	.	13 „

Dissolve in $17\frac{1}{2}$ pints water, boil up, let cool, and stir in nitrate of iron at 49° Tw.

Black liquor at $9\frac{1}{2}^{\circ}$ Tw. . . 2 lb. 3 ozs.

Print, hang up, and steam.

Black, Red, Rose, Green, Yellow, and Blue, on a Violet Ground. Calico.

Pad the pieces in stannate of soda at 1° Tw. for three hours, take through vitriol sours of the same strength for one minute, and then through water. Pad in a solution of $\frac{3}{4}$ oz. casein (lactarine) and the same weight of soda crystals per $1\frac{1}{2}$ pint water. Leave them in this for three hours, take again through sours at 1° Tw., and enter in the dye-beck. For each 12 pieces—154 yards—add to the beck the necessary quantity of solution of aniline violet and $4\frac{1}{2}$ ozs. acetate of soda. Run through the beck for twenty minutes.

Another and simpler way of preparing is:—Pad in stannate of soda at 14° Tw. for three hours, and take through a cistern containing $5\frac{1}{4}$ ozs. sal-ammoniac per 87 quarts of water along with the necessary quantity of aniline violet in solution. Run through this liquid for ten minutes, rinse, and dry. Before printing run over a drum covered with woollen cloth.

Print on the following steam colours:—

Black.

Extract of logwood at 14° Tw.	. . .	$5\frac{1}{4}$ pints.
Bark liquor at 14° Tw.	. . .	9 fl. ozs.
White starch	. . .	$9\frac{3}{4}$ ozs.
Dextrine	. . .	$12\frac{1}{2}$ ozs.

Boil, stir till cold, and add:—

Nitrate of iron at 98° Tw. . . 18 $\frac{1}{2}$ ozs.

And stir well together.

Red.

Cochineal liquor at $8\frac{1}{4}^{\circ}$ Tw.	7 pints.
White starch	$17\frac{1}{4}$ ozs.
Oil	$5\frac{1}{4}$ „

Boil well, and on taking from the fire add :—

Tin crystals	$1\frac{1}{2}$ oz.
Oxalic acid	$1\frac{1}{2}$ „

Rose.

Cochineal liquor at $2\frac{1}{2}^{\circ}$ Tw. or up- wards, according to shade	$2\frac{1}{2}$ pints.
Red liquor at 22° Tw.	17 ozs.
Tartaric acid	$7\frac{3}{4}$ „
Powdered gum	7 „

Let down with weak gum-water, to every 17 pints of which add $1\frac{3}{4}$ pint red liquor at 22° Tw.

Green.

Berry liquor at $9\frac{1}{2}^{\circ}$ Tw.	7 pints.
Red liquor at $15\frac{1}{2}^{\circ}$ Tw.	$1\frac{3}{4}$ „
Blue mixture, as below	7 „
Perchloride of tin	$8\frac{3}{4}$ ozs.
Gum	7 lbs. 1 oz.

Blue Mixture, above mentioned.

Water	21 quarts.
Yellow prussiate	$9\frac{1}{4}$ lbs.
Tartaric acid	$25\frac{1}{2}$ ozs.
Oxalic acid	$25\frac{1}{2}$ „

Steam Yellow.

Berry liquor at $6\frac{3}{4}^{\circ}$ Tw.	.	.	.	1 $\frac{1}{4}$ pint.
Powdered gum	.	.	.	12 ozs.
Tin crystals	.	.	.	8 $\frac{3}{4}$ „

The yellow should be mixed three days before it is wanted.

Prussian Blue.

Water	.	.	.	.	17 pints.
White starch	.	.	.	.	3 $\frac{1}{4}$ lbs.
Tin pulp	.	.	.	.	8 $\frac{3}{4}$ pints.
Sal-ammoniac	.	.	.	.	20 $\frac{1}{4}$ ozs.
Red prussiate of potash	.	.	.	.	3 $\frac{1}{4}$ lbs.

Boil, and stir till cold. For a heavier blue add $\frac{3}{4}$ oz. to 1 oz. nitrate of iron.

The colours after printing are steamed.

White, Blue, Green, and Yellow, on a Turkey-Red Ground.

On the dyed pieces print:—

White.—In 1 $\frac{3}{4}$ pint water dissolve 2 $\frac{1}{4}$ lbs. tartaric acid, and thicken with 27 ozs. pipeclay and 17 $\frac{1}{2}$ fluid ozs. gum-water (at 35 ozs. gum per 1 $\frac{3}{4}$ pint).

Yellow.—Water 7 pints, white starch 20 ozs., oxalic acid 4 lbs. 6 ozs., nitrate of lead 2 lbs. 6 ozs., tin crystals 2 lbs. 3 ozs.

Blue and Green.—Print the mixture from white to which has been added Prussian blue stirred up in water and dissolved with oxalic acid. Green is formed by printing blue over yellow. The pieces are then passed through a discharge beck of chloride of lime at $5\frac{1}{2}^{\circ}$ Tw., and into a chrome beck of 155 grains chromate of potash per pint.

*Red and White on a Grey Ground. First Method.
Tin Solution.*

Tin crystals	4 lbs. 6 ozs.
Bichloride of tin, crystalline	2 lbs. 3 ozs.

Dissolve together.

Dissolve $17\frac{1}{2}$ ozs. sugar of lead, in $1\frac{1}{4}$ pint water. Mix the two solutions, stir, let settle, and use the clear.

Steam Red.

Cochineal liquor, $9\frac{1}{2}^{\circ}$ Tw.	65 pints.
Bark liquor, $30\frac{1}{2}^{\circ}$ Tw.	$3\frac{1}{2}$ „
White starch	11 lbs.
Salt of sorrel	2 lbs. 3 ozs.

Boil up, stir till cold, and add $3\frac{1}{2}$ pints of the tin solution.

22 lbs. cochineal yield 50 pints of liquor at $9\frac{1}{2}^{\circ}$ Tw. For this steam-red may be substituted a pigment-red made of carmine and gum-water.

Steam Grey.

Crude acetic acid at $2\frac{1}{2}^{\circ}$ Tw.	$8\frac{1}{4}$ pints.
Black liquor, 20° Tw.	$1\frac{3}{4}$ „
Solution of blue-stone, 20° Tw.	$1\frac{3}{4}$ „
Sal-ammoniac	$27\frac{3}{4}$ ozs.
Catechu liquor, $2\frac{1}{2}^{\circ}$ Tw.	$1\frac{3}{4}$ pint
Logwood liquor at $6\frac{1}{4}^{\circ}$ Tw.	7 ozs.
Calcined starch	3 lbs. 14 ozs.

This colour may be let down as needful with one, two, three, &c. times its measure of gum-water.

Print, steam for half an hour, age for a day, wash, dry, and finish.

Second Method.—The same style can also be obtained in fast colours. The whites are protected by resists (which see), and the following colours are printed on for the reds and greys.

Red.

Mordant B at $11\frac{1}{4}^{\circ}$ Tw. (see below)	1 $\frac{1}{4}$ pint.
Crude acetic acid at $2\frac{1}{2}^{\circ}$ Tw..	3 $\frac{1}{2}$ ozs.
Bark liquor, $30\frac{1}{2}^{\circ}$ Tw.	1 $\frac{3}{4}$ „
White starch	1 $\frac{3}{4}$ „
Calcined starch	2 $\frac{3}{4}$ „

Boil, stir till cold, and add :—

Tin crystals	1 oz.
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Mordant B, at $11\frac{1}{4}^{\circ}$ Tw.

Boiling water	43 pints.
Alum	22 lbs.

Dissolve, and add :—

Sugar of lead	4 lbs. 6 ozs.
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Grey.

Extract of logwood, 80° Tw.	1 $\frac{1}{4}$ pint.
Berry liquor, $6\frac{1}{4}^{\circ}$ Tw.	7 pints.
Gum-water (containing 35 ozs.)	1 $\frac{1}{4}$ pint.

After printing, age for twelve hours at 95° F., with the wet-bulb thermometer at 86° F. Take through a cistern fitted with rollers, with 1 oz. chromate of potash per 1 $\frac{1}{4}$ pint; rinse, and fly-dung with :—

Water	350 pints.
Dung	7 „
Phosphate of soda	17 $\frac{1}{2}$ ozs.

Pass the pieces for two minutes through this beck at

178° F., and then into a large dung-beck containing 175 pints dung to 525 gallons of water.

Wash, and pass for twenty minutes through a beck at 155° F., containing 43 pints dung per dozen pieces. After each dozen the beck is replenished with 21 pints dung, and it is entirely emptied and renewed after 4 or 5 dozen.

Wash well and dye with alizarine for reds, in the usual manner. Wash, take through boiling water, dry, and finish.

Black, Red, and Brown Furniture Print.

The black is printed first, then the red and brown. The pieces must be prepared in the usual manner for steam-styles. After printing and dyeing, they are steamed, washed, starched on the backs, and dried.

Black.

Logwood liquor, 6 $\frac{1}{4}$ ° Tw.	.	.	26 pints.
Red liquor, 14° Tw.	.	.	7 "
Black liquor, 14° Tw.	.	.	11 "

Mix, and boil up with:—

Wheat starch	.	.	.	6 lbs. 9 ozs.
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Add:—

Olive oil	.	.	.	10 $\frac{1}{2}$ ozs.
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Stir till half cold, and add:—

Muriate of iron, 71 $\frac{1}{2}$ ° Tw.	.	.	7 ozs.
Nitrate of iron, 92 $\frac{1}{2}$ ° Tw.	.	.	29 $\frac{1}{4}$ "

Red.

Sapan liquor	.	.	.	8 $\frac{1}{2}$ pints.
Bark liquor.	.	.	.	42 fl. ozs.
Alum	.	.	.	17 $\frac{1}{2}$ ozs.

Thicken in the usual manner with:—

Wheat starch	27 $\frac{1}{4}$ ozs.
Gum tragacanth	8 $\frac{1}{4}$ „

Stir till half cold, and add:—

Chlorate of potash	4 $\frac{3}{8}$ ozs.
Red prussiate	8 $\frac{1}{4}$ „

Brown.

Dissolve 5 lbs. 7 ozs. catechu in 17 pints water at a boil, filter well, and add:—

Redwood mixture, 25° Tw.	6 $\frac{1}{10}$ pints.
Acetate of manganese	17 „

Thicken with:—

Calcined starch	2 lbs. 3 ozs.
White starch	4 „ 6 „

For the *redwood mixture* take:—

Sapan liquor	70 quarts.
Alum	27 lbs. 6 ozs.
Sugar of lead	22 lbs.

Dissolve, let settle, and use the clear.

Acetate of Manganese.

Dissolve 22 lbs. sulphate of manganese in 17 $\frac{1}{2}$ pints water, and add 22 lbs. sugar of lead. Dissolve, let settle, and draw off the clear for use.

BANDANNA STYLE.

This style is exclusively produced upon cotton cloths intended for handkerchiefs, and its production is generally a distinct business, apart from ordinary calico printing.

The characteristics of the style are white, yellow, or orange spots upon a Turkey-red or deep brown, &c., ground.

This effect could, of course, be produced by the discharge style, upon a Turkey-red, &c., ground, but it is obtained much more rapidly and economically by special machinery without the aid of the cylinder machine. Leaden plates are used, perforated with holes of the exact size, shape, and distances of the spots to be produced. A pile of handkerchief pieces is laid between two of these plates, so that the holes in the upper and the lower lead exactly correspond to each other, and the whole is then subject to a pressure of several hundred tons by being placed in a hydraulic press, specially modified for the purpose.

A solution of bleaching liquor (chloride of lime) is then allowed to flow through the holes in the upper lead plate, and percolate in a straight line downwards, finding its escape through the holes of the lower plate. The immense pressure prevents the bleaching liquor from spreading out laterally, and confines its action to the parts corresponding to the holes.

As soon as the bleaching liquor has passed through, a stream of water is made to pass through in the same manner, so as to wash away the bleach, which, without this precaution, would spread out laterally as soon as the pressure was relaxed, and cause the spots to have a blurred outline. When this washing process has been sufficiently performed, the press is opened and the pieces are thrown at once into water. The result is a pattern of white spots upon the red ground.

The method for producing yellow spots in chromate of lead will easily be understood on reference to the section on the discharge style.

It is stated, that with a proper arrangement of presses, four workmen can print upwards of 19,000 yards of bandannas in a day of ten hours.

PRINTING WOOLLENS.

Goods consisting entirely of wool are printed chiefly in the steam and the spirit styles, modified according to the nature of the tissue. The following are receipts for the production of the most common colours:—

Black (on all-wool Merino).

Orchil liquor at 10° Tw.	1 gallon.
Logwood liquor at 10° Tw.	12½ quarts.
Gall liquor at 20° Tw.	1½ pint.
Starch	4½ lbs.

Boil, and when the starch is thoroughly dissolved, add:—

Blue-stone	$\frac{1}{4}$ lb.
Copperas	$\frac{1}{4}$ "
Extract of indigo	1½ "

Stir till cold, and add:—

Nitrate of iron at 80° Tw.	1 lb. 14 ozs.
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Black.

Extract of logwood at 7° Tw.	2½ quarts.
Water	2½ "
Starch	$\frac{1}{2}$ lb.
Alum	3 ozs.

Boil together, stir till cold, and add:—

Nitrate of iron	8 ozs.
Extract of indigo	3 ozs.

Another Black.

Dissolve 10 lbs. solid extract of logwood in 17½ pints boiling water. Thicken with $\frac{3}{4}$ lb. gum tragacanth; cool, and stir in 2 lbs. pyrolignite of iron at 98° Tw. Print with

this colour, age for two days, and take through a water at 202° F., containing 1 oz. chromate of potash per lb. of woollen. Rinse.

This black requires no steaming.

Another Black.

Dissolve 3 lbs. extract logwood and 1 lb. extract bark in boiling water; let settle, pour off the clear, and make it up to 10½ pints. Stir in 1½ lb. white starch and 1½ lb. calcined starch; boil, and dissolve in the paste whilst hot ½ lb. ground copperas; stir till cold, and add 52 fluid ozs. nitrate of iron and 1½ pint black liquor; stir well. Print, dry, steam for an hour, and rinse.

Black.

Extract of indigo	½ lb.
Sal-ammoniac	1½ lb.
Calcined starch	16 lbs.
Extract of logwood at 9½° Tw. . .	14 quarts.

Boil up, stir till nearly cold, and add:—

Nitrate of iron at 113° Tw. . .	2 lbs.
Muriate of iron at 84° Tw. . .	1 lb.

Stir till cold, and add:—

Oxalic acid	2 ozs.
Chromate of potash	¼ lb.

Black for Woollen Yarns.

Dextrine	6 ozs.
Wheat starch	8 ozs.
Extract of logwood, 8½° Tw. . .	3½ pints.

Dissolve, and add:—

Black liquor, 14° Tw. . . .	1 lb.
Olive oil	8 ozs.

Boil all together; cool, and stir in $1\frac{1}{2}$ oz. nitrate of copper. When quite cold, add 3 ozs. nitrate of iron. Let stand a day before using. Stir well before printing. After printing, let goods lie half an hour in a damp place; steam for an hour; let lie for a day, and rinse.

Fast Black.

Dissolve in water 5 lbs. 7 ozs. extract of logwood; let settle, and make up to $17\frac{1}{2}$ pints. Dissolve therein $13\frac{1}{4}$ ozs. gum tragacanth; stir till cold, and add 7 pints black liquor at $30\frac{1}{2}^{\circ}$ Tw. Print, steam, and rinse. Take through a water with chromate of potash at $1\frac{1}{2}^{\circ}$ Tw., and 122° F. Rinse.

Black.

Dissolve 6 lbs. 9 ozs. solid extract of logwood in 11 pints of boiling water, let cool, and settle. Mix the clear with 17 ozs. black liquor at $6\frac{1}{4}^{\circ}$ Tw., and $4\frac{1}{4}$ ozs. nitrate of iron at 98° Tw. Thicken with $8\frac{1}{2}$ ozs. gum tragacanth. Print, hang up for six hours, and steam for forty-five minutes at the temperature of 212° F. Rinse.

Steam Black.

Logwood liquor	. . .	16 pints.
Sapan liquor	. . .	17 fluid ozs.
Fustic liquor	. . .	17 "

All at 11° Tw. Thicken at a boil with:—

Starch		2 lbs. 3 ozs.
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Add:—

Blue-stone		$8\frac{1}{4}$ ozs.
Copperas		$5\frac{1}{2}$ "
Extract of indigo		7 "

And, when cold:—

Nitrate of iron, 113° Tw.	. . .	$17\frac{1}{2}$ "
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Let stand for twenty-four hours before using.

Dark Blue.

Boil together:—

Water	.	.	.	.	.	2 gallons.
Starch	.	.	.	.	.	1½ lbs.

Boil, and stir in:—

Alum	.	.	.	.	.	1¼ lb.
Oxalic acid	.	.	.	.	.	$\frac{1}{4}$ "
Tartaric acid	.	.	.	.	.	$\frac{1}{2}$ "
Extract of indigo	.	.	.	.	.	3 "

Blue, with a Purple Reflection.

Gum-water	.	.	.	.	.	3½ gallons.
Extract of indigo	.	.	.	.	.	1 lb. 2 ozs.
Alum	.	.	.	.	.	1½ lb.
Cochineal decoction at 6° Tw.	.	.	.	.	.	15 ozs.
Oxalic acid	.	.	.	.	.	9 ozs.

If a more violet shade is wanted, the cochineal is increased; and if a lighter blue is required, the gum-water is increased accordingly.

Royal (i.e. Prussian) Blue.

Water	.	.	.	.	.	1 gallon.
Gum	.	.	.	.	.	7½ lbs.
Alum	.	.	.	.	.	13 ozs.
Oxalic acid	.	.	.	.	.	1 lb.

Dissolve at a boil, and, when cold, stir in:—

Red prussiate of potash	.	.	.	.	.	2½ lbs.
Stannic chloride (oxymuriate of tin)	.	.	.	.	.	$\frac{1}{2}$ lb.
Nitrate of iron at 80° Tw.	.	.	.	.	.	1 lb. 10 ozs.

Dark Brown.

Extract of logwood at 7° Tw.	.	.	.	1 pint.
Extract of Sapan at 7° Tw..	.	.	.	$\frac{1}{2}$ "
Water	.	.	.	4 $\frac{1}{2}$ quarts.
Starch	.	.	.	$\frac{1}{2}$ lb.

Boil together for twenty minutes, stir till cold, and add:—

Nitrate of iron	.	.	.	1 oz.
Sulphate of zinc	.	.	.	2 "

Orchil Brown.

Orchil liquor	.	.	.	25 quarts.
Alum	.	.	.	1 lb.
Oxalic acid	.	.	.	1 "
Starch	.	.	.	3 "
Extract of indigo	.	.	.	1 "

Wood Brown.

Sapan liquor, 6 $\frac{1}{4}$ ° Tw.	.	.	.	2 $\frac{1}{2}$ quarts.
Fustic liquor, 6 $\frac{1}{4}$ ° Tw.	.	.	.	1 "
Logwood	.	.	.	1 "

Mix, and dissolve in the liquid:—

Alum	.	.	.	4 ozs.
Blue stone	.	.	.	1 $\frac{1}{2}$ "
Nitrate of copper	.	.	.	5 "

Thicken with gum tragacanth. Warm slightly, and stir well before using.

Brown.

White starch	.	.	.	24 lbs.
Calcined starch	.	.	.	24 "
Extract of indigo	.	.	.	10 "

Sal-ammoniac	2 lbs.
Orchil liquor	182 quarts.
Water	35 pints.

Boil, and add :—

Alum	16 lbs.
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Blond.

Extract of indigo	$1\frac{3}{4}$ ozs.
Alum	$\frac{1}{2}$ lb.
Oxalic acid	$\frac{1}{4}$ „

Extract of fustic, orchil liquor, and gum-water as required.

Brown for Yarns and Pieces.

Starch	14 ozs.
Water	17 fluid ozs.
Extract of orchil	4 lbs. 6 ozs.
Extract of indigo	$5\frac{1}{4}$ ozs.

Boil to a perfect paste, stir till cold, and then dissolve in the mass :—

Alum	$6\frac{1}{4}$ ozs.
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Print at once, and steam for an hour.

Brown.

Dissolve 35 ozs. extract Sapan and $17\frac{1}{2}$ ozs. extract of bark, both solid, in 11 pints boiling water; let cool, and settle. Thicken the clear liquid with $4\frac{3}{8}$ ozs. gum tragacanth, and stir in $8\frac{3}{4}$ ozs. red liquor at $6\frac{3}{4}^{\circ}$ Tw. If a darker shade is required, add a little black liquor.

Print, hang up for six hours, steam at 212° F., and rinse.

Bismarck Brown.

Take about 1 oz. of the colour, more or less, according to the shade. Dissolve it in 11 pints of water; let cool, and settle.

Thicken with $2\frac{3}{4}$ ozs. gum tragacanth, the same weight of starch, and $1\frac{1}{2}$ ozs. glue. Print, hang up for six hours, steam for forty-five minutes at 189° F., and rinse.

Buff.

Orchil liquor at 22° Tw.	. . .	1 gallon.
Bark liquor		2 „
Alum		3 lbs.
Starch, according to shade.		

Iron-buffs are not practicable upon woollens.

Chocolate (Red Shade).

Ammonia-cochineal paste	. . .	15 ozs.
Alum		$\frac{1}{2}$ lb.
Sal-ammoniac		$\frac{1}{2}$ lb.
Oxalic acid		2 ozs.
Orchil liquor at 16° Tw.	. . .	2 gallons.

Boil, stir well till thoroughly incorporated, strain, and dissolve :—

Starch		2 lbs.
Extract of indigo		6 ozs.

Dark Chocolate.

Orchil liquor		3 gallons.
Oxalic acid		$\frac{1}{4}$ lb.
Alum		$1\frac{1}{2}$ „
Sal-ammoniac		$\frac{1}{4}$ „

Stir till the frothing subsides, and add :—

White starch	2 lbs.
Calcined starch	2 „

Boil and stir till dissolved, and then add :—

Extract of indigo	$\frac{3}{4}$ lb.
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For lighter shades, reduce with gum-water.

Medium Green.

Extract of fustic at $5\frac{1}{2}^{\circ}$ Tw.	1 gallon.
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Thicken with gum tragacanth, and dissolve in the liquid :—

Alum	4 ozs.
Oxalic acid	2 „

Stir till cold, and add :—

Tin composition at 113° Tw.	2 ozs.
Indigo extract	$\frac{3}{4}$ lbs.

Dark Green.

Extract of bark at 17° Tw.	3 quarts.
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Thicken with gum tragacanth, and add :—

Alum	1 lb.
Extract of indigo	$1\frac{1}{4}$ lb.
Tin composition at 113° Tw.	4 ozs.

Light Green.

Fustic liquor at $5\frac{1}{2}^{\circ}$ Tw.	1 quart.
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Thicken with tragacanth, and add the solution of 2 ozs. extract of indigo in $\frac{1}{4}$ pint water, and dissolve in the liquid 1 lb. ground alum.

Green.

Extract indigo	15 ozs.
Alum	5 lbs.
Salt of sorrel	1 lb. 9 ozs.
Yellow paste (see below)	18 lbs.
Gum-water as required.	

For the yellow paste take a decoction of fustic, precipitate it with a little sulphuric acid and bichloride of tin; filter, drain, and use the precipitate while moist.

Light Green.

Berry liquor at 12° Tw.	2 gallons.
Alum	2½ lbs.
Tartaric acid	¾ lbs.
Oxalic acid	6 ozs.
Extract of indigo	1 lb.
Gum water	4 gallons.
Stannic chloride at 100 lbs. (oxy-chloride tin)	1 lb.

Deep Green.

Extract of indigo	6 lbs.
Bark liquor at 17° Tw.	3 gallons.
Sulphate of alumina	3 lbs.
Sal-ammoniac	6 ozs.
Dissolved in water	¾ gallon.

Add :—

Tartaric acid	1½ lb.
Oxalic acid	14 ozs.

Boil till dissolved and incorporated, and add :—

Stannic chloride	1½ lbs.
Yellow prussiate of potash	¼ "
Gum substitute, according to the design.	

Pearl Grey.

Boiling water	3 galls.
Tartaric acid	1 lb.
Extract of indigo	6 ozs.
Alum	1 lb.
Ammoniacal cochineal paste	$\frac{3}{4}$ lb.
Gum-water	4 galls.
Stannic chloride (oxymuriate) at 100° Tw.	$\frac{3}{4}$ lb.

Dark Grey.

Berry liquor, at 7° Tw.	1 $\frac{1}{2}$ pint.
Ammoniacal extract of cochineal	1 gall.
Extract of indigo	$\frac{1}{4}$ lb.
Alum	$\frac{1}{4}$ "
White argol	$\frac{1}{2}$ "

Thicken with gum-water, using a larger quantity for the lighter shades.

Silver Grey.

Extract of logwood, at 7° Tw.	1 pint.
Water	4 $\frac{1}{2}$ quarts.
Starch	$\frac{1}{2}$ lb.

Boil for 20 minutes, stir till cold, and stir in:—

Nitrate of iron	1 oz.
Sulphate of zinc	2 ozs.

Lilac Grey for Woollen Yarns.

Stove, wash and print with the following mixture:—
2 $\frac{1}{2}$ ozs. induline, and $\frac{3}{4}$ oz. methyl violet are dissolved in water. In the solution 17 $\frac{1}{2}$ ozs. gum tragacanth are softened and stirred up, and 8 $\frac{1}{4}$ glue are then dissolved.

Make up with boiling water to $17\frac{1}{2}$ pints. Stir well, print, dry, steam, and wash.

Lilac.

Ammoniacal extract of cochineal	1	gall.
Acetic acid, dilute	$\frac{1}{2}$	"
Oxalic acid	1	lb.
Alum	$1\frac{1}{4}$	"
Extract of indigo	$\frac{3}{4}$	"
Gum-water	4	galls.

When cold, stir in:—

Stannic chloride (oxymuriate tin)	4	lbs.
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Olive.

Berry liquor, $5\frac{1}{2}^{\circ}$ Tw. . . .	$3\frac{1}{2}$	pints.
Cake alum	$3\frac{1}{2}$	ozs.
Copperas	1 ³	"

Dissolve, and thicken with—

Gum	20	ozs.
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Orange.

Bark liquor	1	quart
Tin crystals	2	ozs.

Cochineal liquor, according as a more or less red tone is required. Thicken with gum tragacanth.

Cærulignone Orange.

The paste-colour is dissolved in alcohol and precipitated by water. The sediment thus obtained is thickened with gum in the ordinary manner, and printed upon wool or silk. The pieces are dried, steamed, washed, and taken through a water with bichromate of potash, when a fine orange colour is developed.

Orange for Yarns or Pieces.

Berries	7 ozs.
(Or, flavine, 7 ozs.)	
Water	7 pints.

Extract at a boil, and add to the clear liquid:—

Starch	13 $\frac{1}{4}$ ozs.
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Boil up to an even paste, and into this stir,—

Gum arabic, ground	8 $\frac{1}{4}$ ozs.
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Let stand till the gum is dissolved, boil up again, stir till cold, and add, with careful stirring:—

Tin crystals	8 $\frac{1}{4}$ ozs.
Bichloride of tin	2 $\frac{1}{8}$ „
Oxalic acid	2 $\frac{1}{8}$ „

This shade can be reddened by the introduction of a little cochineal.

After printing, hang up, and then steam for an hour.

Amaranth on Yarns or Pieces.

Boil 12 ozs. orchil in water, and make up the decoction to 1 $\frac{1}{2}$ pint. Boil 4 $\frac{1}{8}$ ozs. cochineal in water, and make up to 27 fluid ozs. Thicken with—

Starch	8 $\frac{1}{4}$ ozs.
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Stir till cold and add, constantly stirring:—

Ground alum	3 $\frac{1}{2}$ ozs.
Perchloride of tin	1 $\frac{3}{4}$ „

Mix thoroughly, print, steam, and rinse.

Steam Red on Woollens.

Dissolve:—

Coralline	3 $\frac{1}{2}$ ozs.
Glycerine	4 $\frac{1}{2}$ fl. ozs.
Water	17 „

Stir up separately :—

Calcined magnesia	9 $\frac{1}{4}$ ozs.
Water	17 ozs.

Mix the two and thicken with 2 $\frac{1}{3}$ pints gum-water.
Print, steam, and wash.

Steam Rose on Woollens.

Cochineal liquor at 5 $\frac{1}{2}$ ° Tw. . .	1 $\frac{1}{4}$ pint.
Water	3 $\frac{1}{2}$ pints.
Red liquor at 14° Tw. . . .	17 fl. ozs.
Oxalic acid	1 $\frac{1}{8}$ ozs.
Gum	3 $\frac{3}{4}$ lbs.

Print with the block and steam as usual.

Or,

Boil together :—

Cochineal liquid	14 quarts.
Ammoniacal cochineal . . .	12 lbs.
Acetic acid	4 „
Water	21 pints.
Alum	3 $\frac{1}{4}$ lbs.
Oxalic acid	1 $\frac{1}{2}$ lb.
Tartaric acid	1 $\frac{1}{2}$ „
Bichloride of tin	3 $\frac{1}{2}$ lbs.

Thicken with gum Senegal.

Or :—

Ground cochineal	1 lb. 1 oz.
Mix with water and boil to .	15 $\frac{1}{2}$ pints.
Gum	6 lbs. 6 ozs.
Oxalic acid	17 ozs.
Bichloride of tin at 112° Tw. .	20 $\frac{1}{4}$ „

Poppy Red.

Cochineal liquor ($\frac{1}{2}$ lb. per 1 $\frac{1}{4}$ pint)	3 $\frac{1}{2}$ pints.
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Starch	10 $\frac{1}{2}$ ozs.
Oxalic acid	4 $\frac{1}{8}$ „
Tin solution	4 $\frac{1}{8}$ ozs.
Bichloride of tin	2 $\frac{1}{8}$ ozs.

To make the above tin solution take nitric acid, 2 lbs.; muriatic acid, 4 lbs.; tin, 12 $\frac{1}{2}$ ozs.

Or:—

Cochineal decoction at 10 $\frac{1}{2}$ ozs. per 1 $\frac{1}{4}$ pint.	7 pints.
Gum	6 lbs. 9 ozs.
Oxalic acid	12 ozs.
Bichloride of tin	2 $\frac{1}{8}$ „

Scarlet No. 1.

Boil out 2 lbs. ground cochineal in water. Thicken with gum tragacanth, cool, and dissolve in the liquid $\frac{1}{2}$ lb. oxalic acid and $\frac{1}{2}$ lb. tin crystals.

Scarlet No. 2.

In 1 gallon cochineal extract at 4° Tw. dissolve $\frac{1}{4}$ lb. oxalic acid and 5 ozs. tin composition as below. Thicken with gum tragacanth.

The tin composition is thus prepared: muriatic acid, 10 lbs.; nitric acid, 7 $\frac{1}{2}$ lbs.; tin, 1 lb. Dissolve slowly.

Scarlet No. 3.

White starch	4 $\frac{1}{2}$ lbs.
Cochineal liquor at 8 $\frac{1}{4}$ ° Tw.	31 pints.

Boil, and add:—

Tin crystals	9 ozs.
Oxalic acid	1 $\frac{1}{2}$ lb.
Solution of tin, 8 $\frac{1}{4}$ ° Tw.	2 $\frac{1}{4}$ lbs.
Extract of fustic, 21 $\frac{1}{4}$ ° Tw.	1 $\frac{1}{2}$ lb.
Oil of turpentine	17 fl. ozs.

Saffranine Red.

Saffranine, according to shade .	10 to 15 grs.
Water	8½ ozs.
Acetic acid	1¼ oz.

Dissolve with the aid of heat, and add :—

Gum-water	24 ozs.
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Orseiline Red.

Orseiline	2⅛ ozs.
Acetic acid	3½ „
Glycerine	1¾ „
Water	29 „

Dissolve at a boil, and thicken with gum or dextrine.

Dark Red.

Make a decoction of orchil, 4 lbs. 6 ozs. to 1¾ pint, and one of cochineal, with 8¼ ozs. to 1¼ pint.

Take—

Cochineal liquor	1¾ pint.
Orchil liquor	5¼ pints.

Add :—

Cake alum	3⅛ ozs.
Starch	17½ „

Boil, cool, and stir in :—

Bichloride of tin	3½ „
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Medium Yellow.

Berry liquor, 5½° Tw.	3½ pints.
Sulphate of alumina	3½ ozs.
Starch	8¼ „

Boil, cool, and add :—

Oxalic acid	$1\frac{3}{8}$ oz.
Bichloride of tin	$2\frac{1}{8}$ ozs.

The bichloride of tin is made by taking 14 lbs. 3 ozs. tin crystals, and passing through it the chlorine from 2 lbs. 11 ozs. manganese and 12 lbs. muriatic acid.

Yellow.

Berry liquor, 4° Tw.	17 fl. ozs.
Starch	$3\frac{1}{2}$ ozs.

Boil, cool, and add :—

Oxalic acid	$\frac{3}{8}$ oz.
Solution of tin	$1\frac{1}{4}$ oz.

(1 part tin dissolved in 4 parts nitric and 4 parts muriatic acid.)

Yellow.

Orchil liquor at 11° Tw.	$\frac{1}{2}$ lb.
Bark liquor at 17° Tw.	2 quarts.
Oxalic acid	1 oz.
Tartaric acid	1 oz.
Alum	3 ozs.
Gum	$1\frac{1}{2}$ lbs.
Oxymuriate of tin at 109° Tw.	3 ozs.

Silk Printing.

Silks and half-silks are chiefly printed in the steam and pigment styles.

The silks are first prepared by boiling for one to two hours with a solution of $\frac{1}{4}$ lb. well-made soap per lb. of goods. They are then sulphured or, by preference, taken through a solution of the bisulphite of soda or of magnesia. After rinsing and drying, they are next steeped for four hours in a sulpho-muriate of tin bath, made by dissolving 1 lb. tin crystals in water, adding 1 lb. sulphuric acid at

sp. gr. 1.84, and letting down with water to 2° Tw. The silk is then washed, dried, and is ready for printing.

Another way of preparing is to dissolve in a very clean wooden cistern 10 lbs. cream of tartar and 3 lbs. perchloride of tin. The solution can be heated to about 130° to 140° F. by the introduction of a coil of lead steam pipe. The handkerchiefs (handkerchiefs are the kind of silk goods most generally printed) are kept regularly turning for an hour in this liquid by means of a wince, drained on a frame, washed, and dried on steam drums, avoiding creases. The prepare-liquor marks about 4° to 5° Tw., and after about 300 handkerchiefs have been mordanted, it must be fed by adding 32 ozs. tartar and 20 ozs. perchloride of tin, the level of the water being kept constant. The cistern generally holds about 80 gallons.

The temperature varies according to the colour to be produced. If the grounds are to be very light, the handkerchiefs are winced in the cold liquid for a few hours. If the deep blue, green, brown, or black grounds are to be produced, the liquid is heated by means of the steam pipe to 140° F. For very fine designs on a pure white ground, the preparing process is omitted altogether.

The following are examples of colours as used for silk-printing.

Black for Outlines.

Water	.	.	.	.	21 quarts.
Logwood liquor, 30° Tw.	.	.	.	.	22 pints.
White starch	.	.	.	.	7 lbs.
Gum substitute	.	.	.	.	20 "
Blue stone	.	.	.	.	2½ "
Copperas	.	.	.	.	2½ "

Boil up, and, when incorporated, cool down to 100° F., and stir in:—

Alum	.	.	.	.	3 lbs.
Extract of indigo	.	.	.	.	3 "
Tallow	.	.	.	.	2½ "

When quite cold, stir in:—

Nitrate of iron, quite dead. . . . 9 lbs.

Just before using, add per gallon:—

Oil of turpentine 9 $\frac{1}{2}$ ozs.

Prussiate of indigo 9 $\frac{1}{2}$ „

The “prussiate of indigo” is thus prepared:—

Extract of indigo acid at 28° Tw. . . 7 quarts.

Yellow prussiate 11 $\frac{1}{4}$ lbs.

The prussiate, pounded, is stirred into the extract till dissolved, an operation which should be performed under a draught-hood, or in the open air. The product is kept in a closed vessel.

Black Grounds.

Decoction of galls at 22° Tw. . . . 9 lbs.

Starch 20 ozs.

Gum-substitute 20 „

Olive oil 3 „

Tallow 8 „

Boil till even, and stir in when cold:—

Black liquor, 26° Tw. 20 ozs.

Muriate of iron, 72° Tw. 12 „

Dark Prussiate Blue Grounds.

Starch 2 lbs.

Tartaric acid 5 „

Oxalic acid 4 ozs.

Yellow prussiate 5 lbs.

Water 4 quarts.

Tin pulp 6 lbs. 10 ozs.

The starch is first dissolved, then the acids, with careful stirring, and when the mixture has cooled down to 100° F., stir in the ground prussiate. The tin-pulp is not added till

the mixture is completely cold. When ready for use, add per quart of colour 4 ozs. gum.

The following is a Prussian blue of a "bloomier" tone :—

Water	5 pints.
Flour	7 ozs.
Starch	1 lb.
Gum tragacanth water	1 pint.

Boil well, pour into a clean tub, and stir in :—

Red prussiate	18 ozs.
Tin pulp	5½ lbs.
Yellow prussiate	2¾ "

When lukewarm, stir in :—

Tartaric acid	3 lbs. 6 ozs.
Oxalic acid, dissolved in ½ pint water	3 ozs.

When quite cold, add :—

Oil of vitriol	3¼ ozs.
Water	3¼ "

Steam the goods on the same day as printed.

Paste for Reducing (i.e. letting down) the above Blues.

Starch	12 lbs.
Water	13 gallons.

Boil, and let grow cold ; stir in :—

Oxalic acid	2½ lbs.
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previously dissolved in :—

Hot water	6 quarts.
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Add finally :—

Tin pulp	8 lbs.
Perchloride of tin	2 "

Gum Prussian Blue.

Gum-water, thick	1 quart.
Water	1 pint.

Boil these articles, and stir in:—

Tartaric acid	1 lb.
Oxalic acid	1 oz.

Then dissolve:—

Yellow prussiate	1 lb.
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And, lastly, stir in:—

Tin pulp	1 $\frac{3}{4}$ lb.
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For letting down this gum blue, the following paste may be used:—

Boiling water	2 $\frac{1}{2}$ quarts.
Gum-water	3 „
Tartaric acid	12 ozs.
Oxalic acid	8 „

Dissolve the acids in the water; incorporate the gum-water, and, when cold, stir in the tin pulp.

Light Extract Blue.

Boiling water	2 $\frac{1}{2}$ pints.
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Dissolve:—

Alum	3 ozs.
Tartaric acid	4 „
Finest extract of indigo	8 „

Thicken with gum-water according to shade.

Orchil Brown.

Orchil liquor at 18° Tw. . . .	11 lbs.
White starch	10 „

Boil, let cool down to 100° F., and stir in:—

Alum	8 lbs.
Sal-ammoniac	2 „
Tartaric acid	3 „

When perfectly cold, add per quart:—

Acetate of indigo at 22° Tw.	8 ozs.
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Or an equal weight of the prussiate of indigo. Without this addition, the colour serves for a red chocolate.

To prepare the acetate of indigo, take:—

Extract of indigo, 28° Tw.	5 quarts.
Sugar of lead	6 lbs.
Water	2½ pints.

Dissolve the sugar of lead in the water, and gradually stir in the extract. Let settle for a few days, draw off the clear, and keep it in a closed bottle.

Wood-Brown for Grounds.

Extract peachwood at 26° Tw.	4 quarts.
Extract logwood at 30° Tw.	3 „
Extract bark at 30° Tw.	3 „
Red liquor at 18° Tw.	6 „
Boiling water	2 „
Sal-ammoniac	3 lbs.
Tartro-acetate of copper	8 „
Gum-water	14 quarts.

Heat to 140°.

For the aceto-tartrate of copper above mentioned, boil up ground cream of tartar 1 lb. in water 1 quart, and put it in a pail with 2 lbs. 5½ ozs. verdigris; stir till all is dissolved, let cool, and decant the clear for use.

Standard Green.

Bark liquor at 30° Tw.	11 pints.
Cake alum	1 lb. 14 ozs.

Heat to about 113° F., and, when the alum is perfectly dissolved, stir in:—

Gum-water 4 quarts.

Add when cold:—

Prussiate of indigo 7 quarts.

No. 2 Green.

Red liquor, 10° Tw. 3 quarts.

Berry liquor, 14° Tw. 3 „

Thick gum-water 3 „

Heat up to 160° F., and stir in:—

Yellow prussiate 7 lbs.

Let cool to about 104° F., and add:—

Oxalic acid 6 ozs.

Tartaric acid 24 „

When cold, stir in:—

Tin pulp 4 lbs.

For the tin pulp, dissolve 44 ozs. yellow prussiate in 8 quarts hot water. In another vessel, dissolve 3 lbs. tin crystals in 8 quarts cold water. Mix, stir, let the precipitate settle, draw off the clear; stir up the sediment with water, and let settle again. Draw off the clear, throw the pulp on a filter, wash it there, and let drain till it becomes a thick paste, weighing for the quantities taken about 15 lbs. Keep in closed jars. If more tin crystals are used the colours obtained will be lighter, but will have more lustre.

No. 3 Dark Green for Grounds.

Standard green, above 7 quarts.

No. 2 green 2 „

Prussiate of indigo 1 „

No. 4 Bright Green.

Berry liquor, 14° Tw.	. . .	6 quarts.
Red liquor, 18° Tw.	. . .	1½ "
Prussiate of indigo	. . .	2 "
Gum water	. . .	3 "

Indigo Green.

Dissolve extract of indigo in ammonia; filter, and keep for twelve days in a closed vessel at from 70°—80° F. As soon as a portion taken out and mixed with dilute sulphuric acid is found to have a green colour, which is permanent on admixture with more acid, the operation is finished. The deposit is collected on a filter, and is then the green indigo in question.

It is mixed with alum, tartaric acid, and thickened with gum, and then serves for a steam-green, just as does ordinary extract of indigo for a steam-blue.

No. 6. Picric Green.

Picric acid	20 ozs.
Extract of indigo	10 "
Alum.	10 "
Tartaric acid	10 "
Boiling water	3 quarts.
Gum-water	2 "
Sulphuric acid (one measure oil of vitriol with two measures water)	5 fluid ozs.

Dark Grey.

Sumac liquor, 7° Tw..	. . .	6 quarts.
Logwood liquor, 7° Tw.	. . .	1 "
Ground alum	. . .	20 ozs.
Tartaric acid	. . .	8 "
Copperas	. . .	1 lb.

Heat together to 120° F., and add when cold:—

Ammoniacal extract of cochineal	1 quart.
Acetate of indigo at 22° Tw.	30 ozs.
Persulphate of iron, 74° Tw.	1 lb.

Thicken with gum water according to shade.

The persulphate of iron above mentioned is prepared as follows:—

Nitric acid (double aquafortis) at 64° Tw.	48 lbs.
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The acid is added to 13 quarts of water in a tub or stoneware vessel; and 192 lbs. copperas in a rough powder is gradually added till dissolved. The product should mark 72° Tw.

Silver Grey for Grounds.

Prussiate of indigo	12 ozs.
Crimson (see below)	1 lb.
Gum-water	1 gallon.

Lilac.

Logwood liquor, 30° Tw.	3 quarts.
Red liquor, 18° Tw	5 "
Ammoniacal cochineal, solid	10 ozs.
Oxalic acid	8 "

Mix, boil for a few minutes, and stir in—

Thick gum-water	2½ quarts.
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Let cool, and add:—

Solution of red prussiate, 24° Tw.	1 quart.
Alum	3 ozs.
Oxalic acid	2 "

Warm slightly till dissolved; let grow cold, and stir in:—

Perchloride of tin, 130° Tw.	1½ oz.
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Olive.

Dark grey (see p. 372)	.	.	2 quarts.
Berry liquor, 14° Tw.	.	.	1 pint.
Gum-water	.	.	2 quarts.

Orange.

Annatto paste	.	.	.	3 lbs.
Boiling water	.	.	.	3 quarts.
Canadian potash	.	.	.	1 lb.

Dissolve up together, stirring well, strain, and add:—

White starch	.	.	.	8 ozs.
Gum	.	.	.	1 lb.

Boil to the proper thickness.

Pink.

Decoction of cochineal, 7° Tw.	.	.	6 quarts.
Boiling water	.	.	2 $\frac{1}{4}$ pints.
Tin crystals	.	.	7 ozs.
Oxalic acid	.	.	14 „
Perchloride of tin	.	.	4 $\frac{1}{4}$ ozs.
Gum-water	.	.	5 quarts.

The oxalic acid is first dissolved in the water and the tin preparations are added last, when the mixture is cool.

Eosine Pinks.

Dissolve the colour, and add $\frac{1}{5}$ oz. to a gallon of gum-water. This small proportion gives a very good pink.

Eosine colours, however applied, should not be washed in hard waters.

Red.

Decoction of cochineal at 8° Tw.	10½ quarts.
Gum	9 lbs.
Tin crystals	17 oz.
Salt of sorrel	9 „
Oxalic acid	9 „

Heat to 100° till perfectly dissolved and when cold stir in—

Perchloride of tin at 130° Tw.	8 ozs.
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Wood Colour (Light).

Alum	16 ozs.
Oxalic acid	¼ lb.
Gum	7 lbs.
Hot water	7 pints.
Fustic-liquor	7 „
Ammoniacal cochineal	7 „

Dark Wood Colour.

Red	4 quarts.
Jonquil yellow	2 „
Green standard	1 pint.
Gum-water	1 quart.

For the red here required see the last but one receipt; for the standard green, see p. 370; for the jonquil yellow, see below.

Yellow (Jonquil).

Alum	22 ozs.
Tartaric acid	12 „
Water at 104° F.	7 quarts.

Dissolve, and stir in :—

Berry liquor at 14° Tw.	10 quarts.
Gum-water	5 „

In silk printing, for all pure, bright shades, the old colours have been, to a very great extent, superseded by the coal-tar colours, which are, for the most part, of very easy application, requiring merely to be thickened with gum Senegal or tragacanth. The artificial gums do not give as good results.

A very considerable proportion of silk goods are still block-printed by hand. A piece of clean white calico is generally laid upon the printing-table over the blanket, and below the piece which is being printed, and travels on along with it. The ground colour is printed last. Blacks, dark browns, &c., are often applied twice.

Black on Half-Silks.

French extract of logwood	. . .	33	ozs.
French extract of fustic	. . .	4½	„
Gum tragacanth	. . .	13	„

Dissolve in water, boil up, let cool, and stir in :—

Nitrate of iron at 49° Tw.	. . .	17½	ozs.
Black liquor at 9½ Tw.	. . .	35	„

Stir well up, print, hang up for 24 hours, and steam strongly.

Blue.

Gum tragacanth	. . .	17½	ozs.
White glue	. . .	4½	„

Boil together and dissolve in the liquid—

Soluble blue (aniline)	. . .	1½	oz.
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Make up to 17½ pints, boil again, let cool, and print. Hang up and steam.

Green for Half-Silks.

Take 17½ ozs. egg-albumen; allow it to swell up in water, and add 3½ ozs. ammonia and the same weight of

methyl-green, and 1 oz. 45 grs. picric acid. When perfectly dissolved, make up to $17\frac{1}{2}$ pints, print, dry, hang up for 24 hours. Steam for half an hour at 167° F., and rinse.

For lighter shades reduce the methyl-green and picric acid.

Red for Half-Silks.

1 oz. extract cochineal at 7° Tw., which, for heavy shades, may be doubled.

1 oz. berry liquor at 7° Tw. Thicken with $17\frac{1}{2}$ ozs. gum tragacanth mucilage, boil, stir till cold, and dissolve in the liquid $8\frac{1}{2}$ ozs. oxalic acid and $3\frac{1}{8}$ ozs. tin crystals.

Print, dry, hang for 24 hours, and steam for an hour at 212° .

Violet for Half-Silks.

Prepare as for green, but use as colour $3\frac{1}{8}$ ozs. gentiana-violet or $1\frac{1}{2}$ oz. methyl-violet.

Yellow.

Boil up $1\frac{1}{8}$ oz. berry liquor, at 7° Tw., with $17\frac{1}{2}$ ozs. gum tragacanth. Stir till cold and add:—

Tin salt	.	.	.	.	$3\frac{1}{4}$ ozs.
Oxalic acid	.	.	.	.	$8\frac{3}{4}$ „

Add a little cochineal, if a redder shade is wanted.

COLOURS AND COLOUR MIXING.

We have here a term which is used to convey several very distinct meanings, both in common life and in the tinctorial arts, the necessary result being a considerable amount of confusion. Thus, in one sense, we speak of red, blue, green, &c., as “colours.” In another acceptation we give the very same name to indigo, eosine, cochineal, saf-

flower,—in short, the bodies, whether natural or artificial, simple or compound, which communicate “colours,” in the first sense of the word, to any white or colourless body upon which they may be applied.

Again, in the madder style of printing, “colours” are the mordants to be fixed upon the cloth previous to its being dyed, though producing no colour at all. Lastly, a “colour” in other styles of printing is the mixture of colouring matters, mordants, and thickeners, which, when applied to the tissues, produces the design.

It is with colours in the two latter senses of the term that the calico-printer is most directly concerned.

The preparation, or mixing the colours and mordants to produce any required shade under any given circumstances, is, in reality, the most essential part of calico-printing. The ingredients to form a colour must be well selected and properly incorporated together. The mixing house, or “colour shop,” is fitted with an extensive range of colour pans, holding from half a gallon to 28 gallons, or upwards. They are very generally made of copper, though in some cases pans made of block-tin, or lined with tin or with an acid-proof enamel, are preferable. Whatever is the material, absolute cleanliness is essential. Heat is applied by means of steam, which passes between the pan itself and an outer casing, or steam-jacket, and is regulated by means of taps. There are arrangements for the supply of hot and cold water, and the entire pan is generally made to revolve on pivots, so as to be the more easily emptied and cleaned. As it is sometimes necessary to cool a colour quickly, the steam can not only be cut off, but a current of cold water can be caused to pass through the steam-jacket in its place.

During the whole time that the ingredients of a colour are being boiled, they are constantly stirred, and this operation is, in many cases, continued until the mixture is cold. This tedious task was formerly performed by boys, who were known as “gum-sticks,” but in all large estab-

lishments the colour-pans are provided with mechanical stirrers. An excellent arrangement for this purpose has been devised by Messrs. Mather and Platt.

The last step in colour-mixing is straining. It is absolutely necessary that the colour should form a perfectly uniform semi-fluid, free from any grit or coagulation. This was formerly done simply by pouring the colour upon a piece of fine lawn or silk, stretched over the top of a tub. Now, the straining is done by means of a machine, *e. g.*, that of Ridge and Co., and is thus performed more quickly and satisfactorily.

The length of time for which a colour can be kept after mixing varies, both according to its nature, and according to the temperature. Much time and trouble are saved by keeping in the colour-house a set of so-called "standards." These are mixtures of colouring matters and mordants not liable to undergo change or decomposition, and which merely require the addition of a thickener, or of some other ingredient, to be ready for printing.

Some colours occasion great annoyance in working, by their tendency to froth. Not merely soapy, albuminous, and glycerine solutions retain bubbles of air if shaken or stirred up; but the acetates of alumina, lime, soda, and iron, so often present in colours, communicate the same property. This troublesome property may generally be got rid of by the admixture of a little oil of turpentine, light petroleum essence, or similar liquids.

If pigment colours mixed with albumen begin to froth, the addition of a little ammonia is often useful.

THICKENING.

In printing, as distinguished from dyeing, it need scarcely be said that the action of the mordants, colours, &c., has to be strictly confined to certain sharply-defined portions of the tissue. If the colours, &c., spread or "run," the clearness of the design is lost, and the goods are spoiled.

Hence the colours have to be applied, not like the preparations of the dyer, in a liquid state, but as pastes or semi-fluids of different degrees of consistency. Hence the necessity for thickeners, *i.e.*, bodies which are incorporated with the colour to give it the required physical texture. The bodies chiefly employed are flour; starch, as obtained from wheat or from the potato; true gums, such as gum arabic and gum Senegal, varieties of bassorine, such as gum tragacanth; and the artificial gums obtained from starch by different processes, and known as British gum, calcined starch, gum substitute, &c.

In the use of these names there is some confusion. Calcined starch, as its name implies, is made by roasting farina, *i.e.*, potato starch, and is either light or dark, according to the degree of temperature which it has undergone. British gum is a name originally given to roasted wheat starch, but other kinds of starch are now wholly or in part substituted for wheat starch. This kind, also, is either light or dark. Gum substitute is sometimes taken to mean the same article as British gum, whilst others apply the name to potato, or wheat starch, converted into gum by the action of acids. Dextrine is starch, wholly or partly converted by the action of malt. Treacle and glucose are rarely employed, and the so-called animal, or rather albumenoid thickeners, *i.e.*, albumen, casein (lactarine), gelatine, and gluten, are rather mordants than thickeners, since they remain upon the fibre in combination with the colour, and are not washed away after the printing has been performed.

Mucilage of linseed, and of carrageen, salep, sago, &c., are not in general use.

Lastly, we have certain mineral bodies, especially pipe-clay and sulphate of lead, which occasionally play the part of thickeners.

These thickeners are very different in their action, and the selection of such as are suitable for the purpose in hand, is not the least important duty of the colour-mixer. His choice must depend on the nature of the colours and

mordants to be applied ; on the process of printing, whether block or machine-work ; and even on the character of the design or pattern, as heavy or light.

Some thickeners are entirely insoluble in cold water, others are partially soluble, and others, like gum arabic, are perfectly soluble ; in tenacity they differ greatly. In other words, a smaller quantity of one thickener gives as much consistence to a liquid colour as does a larger quantity of another. Thus, in equal quantities of water, 20 ozs. of starch are equal to 22 ozs. wheat flour, 10 ozs. gum tragacanth, and 8 to 9 lbs. of calcined starch. This thickening power is a very important point, since other things being equal, the gum, &c., which thickens most is in practice the cheapest.

To test the strength of a sample, it is dissolved in water, so as to form a very dense jelly, placed in a tall glass, and tested with the viscosimeter. This is an instrument with a brass disc, capable of being loaded with weights. The more weights have to be added to force the brass disc to sink into the jelly, the better is the quality of the gum. The indications are, of course, comparative. The hydrometer (Twaddle) may be used in testing the value of gum waters up to 1 oz. gum in 5 of water ; but beyond that proportion the indications become untrustworthy. This method is only valuable, however, for comparing samples of gum of one and the same kind. Others judge of the viscosity of a gum by its degree of susceptibility to capillary attraction. The more slowly a gum-water, made with known proportions, ascends a slip of unsized paper, the better its quality. Still, an absolute test for judging of the viscosity of a gum is not yet available.

It is necessary that gums should not injure the brightness of delicate colours, and must not weaken the mordants. To ascertain this point, comparative printing trials on a small scale are performed.

To decide on the action of the sample, if any, upon colours, the following mixture is made up :—

Ammoniacal cochineal	35 fl. ozs.
Cochineal (extracted in 35 fl. ozs. water)	1 oz.
Powdered alum	$\frac{3}{4}$ "
Oxalic acid	$\frac{5}{8}$ "

Thicken with 13 ozs. of the gum in question previously ground. Strain through a silk sieve, print on white woollen, steam, and wash. The colour, if the gum is good, is of a fine delicate rose, free from a yellow tinge.

The action of the gums upon mordants is very variable, and may be judged by their degree of acidity, which is readily detected. This defect is rare in gum arabic, but it may produce severe injury with artificial gums not freed from acids, and used, *e.g.*, for thickening a light rose mordant.

The following colour may be used to find the action of gums upon mordants:—

Divide $1\frac{3}{4}$ pint of red liquor into 32 parts, and take one of them.

Make it up with water to $17\frac{1}{2}$ fl. ozs., and dissolve:—

Alum	$8\frac{1}{2}$ ozs.
The gum in question, ground	$8\frac{1}{2}$ "

Boil in the usual manner, stir till cold, and print with it upon a swatch of white calico. This is then aged, dunged, dyed with alizarine, and cleared, and should give a fine light rose; but if the gum is acid, scarcely any colour will be found upon the texture.

Another possible defect of gums is that they may coagulate along with certain drugs, such as catechu or salts of lead. To test gum for this property, take:—

Catechu, melted and broken up	$4\frac{1}{2}$ ozs.
Acetic acid	$4\frac{1}{2}$ "
Water	$12\frac{1}{2}$ "

Heat in the water-bath, stir till dissolved, and work in:—

Sal-ammoniac	$3\frac{1}{2}$ ozs.
Acetate of lime at $21\frac{1}{2}^{\circ}$ Tw. . . .	$3\frac{1}{2}$ „
Gum (sample in question)	$8\frac{1}{2}$ „

Stir well, and add when cold :—

Nitrate of copper at 98° Tw. . . .	$1\frac{1}{2}$ ozs.
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Strain through silk, and let stand for twenty-four hours. If it has not coagulated, the gum may be pronounced in this respect of good quality.

Another possible, and not uncommon, defect of gums and starches is grittiness, *i.e.*, the presence of finely divided silica. . This impurity is of little consequence in block-work ; but, in machine-work, it injures the cylinders and the doctors. It is often so fine that it cannot be separated even by the finest strainers. The presence of grit may be easily detected by dissolving a few pounds of the sample with small quantities of acid, letting settle, decanting off the liquor, washing the residue with water, and finally drying up in a copper or, better, platinum dish, and igniting the sediment, so as to destroy organic matter, and obtain the silica pure, when it may be weighed.

Glucose or other saccharine matter is objectionable, since, in presence of metallic salts, *i.e.*, compounds of iron, tin, &c., it interferes with the ordinary reactions of the mordant and the colouring matter, and hinders combination. The presence of sugar is also apt to bring on fermentation, and cause the mixed colours to spoil.

The penetrative power of the different gums varies also, and affects that of the colours with which they are mixed. As a rule, it is desirable to keep the colour on the surface of the tissue, both as a point of economy, and because the colours appear brighter and clearer. Hence a penetrative gum or other thickener is not to be desired.

Neither should the thickening agent be capable of forming any chemical combination with the mordants or colours.

Gums, &c., have been already divided into three classes,

according to their solubility in cold water. The insoluble class, as a rule, thicken more than do the soluble ones, or gums. But some of them, at least, such as starch and flour, have great penetrating power, and are consequently, in so far, wasteful. Thickeners dilute or lighten the colour. Hence, for dark shades it is necessary to select a very viscid thickener, so that a relatively less proportion may be required.

Mineral thickeners have the disadvantage that their specific gravity is very much greater than that of the organic colours with which they are combined. Hence, on standing, such mixtures are apt to separate and become unequal. They are also apt to be gritty, and are hence more used in block than in machine printing.

The art of combining different gums, starches, &c., so as to work well together, can only be acquired by experience. But it may be said that the thickeners to be mixed together for use in any one colour should not be too widely distinct in their nature, at any rate, unless a third substance of intermediate properties is added.

It is also impossible to give any definite rules for adapting the thickening to the character of the design. Experience—observant experience, rather—must here be the guide.

PRINTING.

The actual printing, that is, the application of the colours to the tissue, is a purely mechanical process. Formerly, this operation was entirely performed by hand. The design, or rather, portions of it, was applied by means of blocks. These are pieces of some hard, fine-grained, wood, such as pear or sycamore, about 9 to 10 inches long, by 5 broad, and from 2 to 3 in thickness, fitted at the back with a stout handle. Upon the face of the block the design is carved much in the same manner as a wood engraving. Sometimes, the pattern is formed by slips of copper, *i.e.*,

flattened copper wire, inserted along its outlines, which are first traced upon the wood. The copper slips are carefully bent to the required shape, and are then forced into the positions they are to occupy by gentle hammering. The upper edges, where the copper stands above the wood, are levelled with the file, so as to form one even surface, and polished. The intervals between these slips are filled up within the boundaries of the design with pieces of thin felt.

In hand-block printing the piece to be operated on is spread out evenly upon the printing table—a strong structure, fixed so as not to rock or shake. It is generally about a yard high, two yards long, and three feet wide. Its top, upon which the piece rests, is a smooth, level slab of flag-stone, from 4 to 5 inches in thickness, and it is covered with blanketing, stretched tightly across, and secured at the sides by hooks. At one end of the table is a roller, supported by brackets, and on it the piece to be printed is coiled, so that it may be drawn over the table as wanted.

Close to the printer stands a so-called colour tub. A wooden drum, like the woodwork of a sieve, is covered with a waterproof tissue, over which is stretched a fine woollen cloth, upon which the colour is spread. This drum is placed so as to float on a tubful of old paste.

The printer begins operations by unrolling a part of the piece from the roller above mentioned, and laying it smoothly over the top of the table. The selvage of the cloth is kept towards him, and runs at about an inch from the edge of the table. He observes how much of the piece will be covered by the block, and marks this by a line with a tracing-point. Meantime, a boy, known as the tearer (probably, *tireur*) spreads out the colour evenly with a brush, on the drum-head. The printer then applies the face of his block to the drum-head twice, in different directions, so that it may be sure to be evenly supplied with colour all over. He then lays it carefully upon the cloth and strikes it on the back with a hammer, or presses

heavily upon it, so as to force the colour into the cloth. In the meantime, the tearer brushes the colour up, so that it may always present an even surface. The printer lifts up his block, charges it afresh with colour, and re-applies it to the piece. Here is now need of great accuracy in working. If he brings his block too close to where he placed it before, the impressions will, to some extent, overlap. If it is not brought close enough, a narrow interval will remain unprinted. If the sides of the block are not kept perfectly parallel with the edge of the piece, the design will necessarily become distorted. Accuracy in these points is secured by means of pin-points, fixed in the four corners of the block, so that each application may be made precisely where the former one left off. Judgment is also needed as to the quantity of colour taken up by the block at each application. If this is insufficient, the design may be too faint, and is said not to be "furnished." If too much colour is taken, smearing and spreading are the consequence. Hence, a block-printer requires no little experience before he can work both well and with reasonable despatch.

When the length of cloth which has been drawn out and laid upon the table is thus printed, more is uncoiled, and the first portion is passed over one of a series of rollers, fixed overhead, so that it may dry without being in the way or in danger of being smeared. The printer thus goes on till the entire roll is finished.

The great drawback to this method of printing is the expenditure of time and labour involved. If we suppose a piece of calico of the ordinary length of 28 yards, by 2 feet 6 inches, to print it over with the block of the size above mentioned will require 672 carefully managed applications. If there are four or five colours—nothing at all uncommon—the number of distinct applications will be respectively 2,688 and 3,360. Each block serves only for such parts of a design as are in one and the same colour. If we suppose, then, the colours in a design are red,

brown, yellow, and green, when, *e.g.*, the reds are all printed, the piece must be allowed to dry till there is no further damage of smearing, and a block with one of the other colours is then applied over the whole surface, in the same manner as before. Thus, in a many-coloured design, time and labour become very serious items.

For the generality of work blocking has therefore been laid aside in place of cylinder printing, of which we shall speak below. The block still retains a considerable importance in particular styles of work. Thus, in many cases, after a piece has been printed with mordants or resists, and dyed in the madder or indigo styles, further colours have to be superadded, in order to complete the design. These are then blocked in by hand, in the manner described above. As, however, this way of working necessarily involves additional expense, it becomes the object of printers to discover such ways of producing colours as will allow the entire design to be completed at once.

Block-work is largely used in printing woollens and mixed goods, such as delaines. The reason is that the fibre of wool is less easily wetted than that of cotton, and requires a larger proportion of colouring matter to produce any given depth of shade. Hence the block which forces the colour into the fibre, has the advantage over the cylinder, which is brought in contact with the piece in a less forcible manner. Colours for these two different methods of working are mixed in a different manner; those for block-work being wetter, *i.e.*, thinner in consistence. In colours for block-work the mineral thickeners, such as pipe-clay, can be used with greater safety than in machine work, since the presence of grit is less injurious. Dark shades on some fine, soft woollen goods, are not merely by preference printed with the block, but one and the same part of the design may have to be blocked two or three times before it is thoroughly furnished.

Before block-printing, the pieces are smoothed in the

calendar, so as to leave the surface perfectly level, and, to a certain extent, glazed.

Printing in reserves by hand may now be considered as entirely superseded.

Certain modifications of the arrangements for block-work have been devised. Thus, a considerable amount of labour is saved by Hudson's mechanical tearer—a contrivance not to be intelligibly described without the aid of diagrams, or better, of a model. Its object was to dispense with the children who attend upon the block-printers, but it never came into general use.

The "Toby," or Tobying sieve, is a device for applying several colours with one block, thus economizing blocks, and the labour of several successive operations is dispensed with. It consists, substantially, of a colour-box, divided into compartments, and so arranged that different portions of the block may always be supplied with different colours.

This device is applicable where the colours of the design lie, so to speak, in distinct strata, but where, as is usually the case, they intersect, and lie immediately bordering upon each other, it is inapplicable.

The effects known as rainbows (*Fr. fondus*), where colours appear in parallel stripes, melting into each other, as in the rainbow, are produced by means of a colour-box in parallel divisions, each filled with one of the shades of colour. A so-called colour-lifter is employed, which is a piece of wood fitted below with pegs, set at certain intervals. When the lifter is applied to the box, the pegs dip into the compartments, and withdraw a certain quantity of colour, which is transferred to the colour-sieve. Further portions are then lifted out in the same manner, and placed upon other parts of the sieve in such a manner that each shade is in a straight line with the portions of the same shade which have been already deposited upon the sieve. They are then brushed up and down by the tearer till they are mingled at the edges, without being confounded toge-

ther, and are then taken up and applied with the block in the usual manner.

The first step towards a method of printing more rapid than block-work was the use of flat plates, applied by means of a press very similar to that used in copper-plate printing. This kind of work, known as the flat-press, was in vogue for some time at Mitcham. The designs thus printed show great neatness and correctness in outline and shading, and were mostly executed in one colour only. They were, in fact, engravings executed upon calico instead of paper.

A very important step was the invention of the Perrotine. This may be best characterized as a machine for performing block-printing without manual labour. It wields three blocks, much larger than those used in hand-printing, their length being equal to the width of the piece, and their width from 2 to 5 inches. They are engraved in the same manner as the hand-blocks. As each machine works three of these blocks, it executes in one operation designs in three colours. The machinery employed is of such a character that no description would render its working intelligible; it may suffice to say that the blocks are pressed against the cloth by certain springs, which represent the action of the block-printer's hand. One of these machines does an amount of work which would require, if done by hand, twenty printers, each with his attendant tearer, and is managed by a single workman, assisted by two children.

The perrotine has been but little used in England, but it has been very generally adopted in Alsace and in Belgium.

By far the larger part of tissue-printing is now executed with the cylinder machine, a Scotch invention, due to a certain Mr. Bell (1785), and first used on the large scale by Livesey, Hargreaves, and Co., of the Mossly Works, near Preston, Lancashire. Since then it has undergone many improvements, and has been adapted for applying at once as many as twenty distinct colours. If we suppose,

for instance, a three-coloured design—blue, yellow, and red—the blue portion of the design is engraved upon one copper cylinder, the yellow portion upon a second, and the red upon a third. This cylinder is supplied with colour by means of a roller which revolves in the so-called colour trough, and transfers a portion of the contents to the design cylinder. Lest the colour should be in too great quantities, a so-called “colour doctor,” *i.e.*, a sharp scraper of steel or gun-metal, is made to press against its surface, and remove any superfluity. These doctors have a slow vibratory motion from right to left, and thus scrape the surface of the pattern cylinder gently. It is of great importance that their edges should be sharp and perfectly even. Hence the colour should neither act upon them mechanically, as by the presence of grit, nor chemically, as when an excess of acids or of acid salts occurs in the mixture. Close to the design-cylinders revolves the pressure cylinder or “bowl,” made of iron, and generally 2 feet in diameter, and from 3 to 4 feet in length. It is coated with folds of woollen-cloth or felt, so as to form a uniformly elastic surface. Around it travels an endless web of blanketting or felt, and over this passes the piece to be printed, which is thus pressed against the engraved (design) cylinder, and receives the colour-impression. After this latter cylinder has been thus in contact with the cloth, it is scraped by the “lint-doctor,” an edged ruler similar to the colour-doctor, but having no motion. Its office is to remove any threads which may have been detached from the cloth, and which, if let remain, would occasion smears, or blur the design.

For every colour in the design to be printed a separate colour-trough, supplying roller, and engraved cylinder, with its doctors, are required, all arranged around the bowl. Each engraved cylinder applies that portion of the design which requires one colour. The adjustments to insure all these parts working accurately together are to be classed among the greatest marvels of mechanical engineering,

and cannot be rendered intelligible by any mere description.

The speed with which these cylinder machines work is such that, in the simpler styles, a mile of calico can be turned out per hour, as far as the mere printing is concerned.

As regards the economy of labour, one man, assisted by two boys to attend to the colour-troughs, can do as much work as one hundred block-printers, each with his attendant tearer.

The engraving of the copper design-rollers is a matter of great nicety, and has given scope to much inventive talent.

The original design has first to be enlarged or contracted to such a size that, when repeated twice, thrice, &c., it may exactly cover the circumference of the roller to be produced. A roller of soft steel is then selected, of such a size that the design may exactly cover its circumference, and upon this the pattern is engraved in intaglio, as, *e.g.*, in a seal. These steel rollers are about 3 inches in length, and may vary in diameter from $\frac{1}{2}$ inch to 3 inches. When the engraving is completed, the roller is hardened by a process well known to workers in steel, and which need not be here described. It is next put into a peculiar press, where it is forced against another roller of soft steel of exactly the same size, to which it transfers its impression in relief, *e.g.*, as in a coin or a medal. This, too, is hardened as above, and is made to transfer its impression to the copper printing cylinder. The machinery used in this process cannot be here described. Indeed, cylinder-engraving is more and more becoming a distinct business.

In the earlier days of calico-printing, when the number of pieces produced was smaller, and time of less importance, they were stitched together by hand, end to end. This work is now done by machinery, perhaps the most approved device being that of Birch.

The pieces thus fastened together are coiled in rolls of about forty by means of a machine known as a candroy or

canroy, which places them on a wooden beam fitted behind the printing machine. It is essential that the pieces are kept quite free from creases or wrinkles.

Yarn-printing is now a distinct and not unimportant branch of tissue-printing, and is applied both to cotton, linen, jute, silk, and woollen yarns. Such yarns may afterwards be woven along with ordinary white yarns, and the cloth may receive no further treatment, or it may be dyed, when the impression on the warp constitutes a pattern; or, again, a design may be printed upon the cloth. In this manner, a class of effects are obtained which cannot be produced by mere printing upon the cloth, nor yet by means of dyed yarns woven in the Jacquard loom.

When this procedure was first introduced, the yarns (warps) were stretched out at length between rollers, and travelled over a table, the colours being then blocked in by hand. For silk warps, these tables are generally from 13 to 16 yards long. The threads are kept in their proper positions, and, as far as possible, in an equal state of tension, by means of "reeds" and rollers. Very considerable care is needed in the application of the colours, especially if several colours have to be blocked on in succession.

In order to economize time, and to do away with the trouble of fixing the yarn, so as to form a warp, and keeping it in this state during the processes of printing and drying, machines have been introduced which print yarns in the hank, and apply several colours at once.

In printing many-coloured yarns in the hank, the yarn had to undergo as many distinct printing and drying processes as there were colours; moreover, as the different colours of the design did not always register well together, much yarn was imperfectly printed, or even spoiled—a circumstance which greatly limited the development of this style.

The chintz-yarn printing machines of Messrs. T. Barraclough and Co. obviate these evils, and are capable of printing as many as six colours at once.

The actual printing operation is performed by means of two brass printing rollers, between which the hank is passed. The yarn receives the printed impression on one or both sides, according to the number of colours. Each printing roller is in connection with three so-called furnisher rollers of brass, which supply it with colour; these are in turn supplied with colour by auxiliary furnishers of brass, revolving in copper troughs containing the colours. The printing rollers are cut or fluted longitudinally, according to the design and colours to be produced. Each furnisher roller is also fluted, according to the colour which it has to supply to the printing roller. The auxiliary furnishers are plain turned rollers without flutings.

If we suppose that the design to be produced consists of six bars—red, blue, yellow, black, green, and brown—one of the printing rollers is, therefore, fluted, so as to apply the red, yellow, and green, while the other roller prints the alternate colours, blue, black, and brown. The first furnisher roller, belonging to one of the printing rollers, is fluted in such a manner, and at such intervals round its circumference, as to impart its colour (red) to the corresponding flutes on the printing roller. The second and third furnisher rollers are fluted, so as to hand over their respective colours (yellow and green) to the corresponding flutes on the printing roller. In the same manner, the other printing roller is supplied by its furnisher rollers with the three colours, blue, black, and brown, according to the corresponding flutes of the pattern. By a special arrangement in the machine the flutes of the two printing rollers, when more than three colours are being printed, do not arrive simultaneously at the point of contact with the yarn, or a smear would be caused. Whilst one flute of one of the rollers is impressing its colour upon the yarn, the corresponding part of the other roller is blank, and *vice versa*. Thus the rollers print alternately.

To insert the hanks, the machine is opened, and the hank is carefully spread out evenly over the entire surface

of the printing rollers, and stretched by means of small tension rollers fitting into racks. The machine is then closed, and the printing is effected by turning a handle attached to one of the printing rollers. When finished, the hank is removed by opening the machine and slackening the tension.

As all the rollers are driven by finely-cut wheels, it follows, of course, that, when once adjusted, they must all keep their respective positions. Hence the colours are each delivered at the proper time, and no misprints can occur. In the operation as described, one printing roller prints three colours on one side of the yarn, whilst the other roller impresses its three colours on the other side of the yarn. When only two or three colours are to be printed, the corresponding flutes of both rollers can be arranged to come together, and apply their colours at once, thus printing the yarn on both sides.

The machine is more conveniently worked by hand than by steam, as the process is intermittent.

If the design to be produced has very broad bands of colour, a piece of felt is let in in the centre of the flutes on the printing rollers, so as to enable them to carry evenly the necessary quantity of colour, and apply it evenly.

It will be at once evident that the designs possible in yarn printing are necessarily limited in their character. Whether applied by block or machine, they consist of bands or stripes, broad or narrow, single or multiple, continuous or interrupted, and running either at right angles to the length of the yarn, or diagonally. As after weaving, the pieces produced are very frequently dyed, padded with a ground, or printed with some large design, the colours employed in yarn-printing are generally heavy.

As yarns are often not rinsed after printing, and as they have further to bear the strain of weaving, it is highly important that they should not be "tendered." Hence free acids and acid salts should be avoided as much as possible in mixing the colours.

DYEING ARRANGEMENTS.

In several styles of printing, more especially in madder work, piece-dyeing is an essential part of the process. After the mordants have been printed on, fixed by ageing, and after the thickenings and the superfluous mordants have been removed by dunging, the goods are run through a dye-beck. The manner of working differs little from that usually employed in dyeing. The beck is of a rectangular figure, longer than broad, and through it the pieces travel at a uniform speed, capable of adjustment, by means of rollers fixed below the surface of the dye-liquid. Great care is taken that the pieces remain spread out to their full width during the whole process, as, if any wrinkles or folds occur, the shades dyed will be uneven.

There are many mechanical arrangements in use for drawing the pieces at an even rate through the dye-becks.

On leaving the dye-beck, or any other cistern in which the goods have been exposed to the action of a liquid, they are squeezed or, as it is technically called, "nipped," by being made to pass between a pair of rollers.

WASHING APPLIANCES.

In all dyeing and printing processes, washing is an important and very frequently recurring operation. In the earlier career of the tinctorial arts, goods requiring to be washed were simply suspended for a time in the stream on the banks of which the works were situate.

This primitive arrangement was abandoned when the rivers became too dirty to be safely used in this manner; and when it was found that a smaller volume of water, if made to come in contact with the goods with very great rapidity, was more effectual than the slow current of a river.

One of the earliest washing appliances introduced was the dash-wheel. This is an upright hollow wheel or drum, revolving on a horizontal axle. It is generally about 5 or 6 feet in diameter, by 2 feet from front to back. It is divided into four compartments by partitions, which extend from the axle to the circumference, and each of which has a round opening on one of the perpendicular faces of the drum. The cloth to be washed is introduced through these openings, and the wheel is made to revolve rapidly. Water may be admitted in two ways. In some cases, the wheel revolves in a cut taken from the river, and at such a depth that the water rushes in at the hole which is undermost. A more common arrangement is to have a water-pipe within the hollow axle on which the drum revolves, and fitted with holes, so as to admit the water into every compartment. The dash-wheel is now very generally superseded by superior washing machines, whose action admits of being regulated with more nicety.

A piece of apparatus often used for more delicate work is the so-called "rinsing machine." This is simply a cistern of wood, about 3 feet wide, 20 to 30 feet long, by 4 feet high at the front end, and 3 feet at the back or entrance end. The cistern is divided into upright compartments, from six to ten in number, by means of wooden partitions, which correspond in height with that of the cistern itself. A stream of water is admitted at the higher end, and finds its way from the first to the second compartment, and so onward, through holes pierced near the top of each division. The cloth to be rinsed enters over a roller at the lower end, passes under a roller placed at the bottom of that compartment, and travels in this manner through all the cells, meeting the stream of water, and finally passes out from the highest compartment through a pair of nipping rollers, by the movements of which its speed is regulated.

The Swiss washing machine—that of Witz and Brown—is very frequently used in this country. It washes about

6,000 to 8,000 yards per hour, with two men to attend to it. It requires from 4 to 5 horse-power to work it, and must have a water-supply of about 4,360 gallons per hour. It may be used for light as well as for heavy goods. The "clapeau-traquet," much employed in France, is best adapted for heavy cloth. It washes as much as 9,000 yards per hour, and requires the attendance of only one man, and a driving power equal to 3 to 4 horse-power. The construction and operation of these machines cannot be made intelligible by a mere description.

DRYING.

The pieces require drying both after and before printing and dyeing, and, occasionally, in intermediate stages. Before printing, the goods should be dried with caution; if they are either damp, or absolutely dry, the results are not satisfactory. Mordants, colours, &c., should not be exposed to a very high temperature in drying. About 200° F. is generally quite sufficient, and the boiling temperature is decidedly too high.

The old arrangement for drying was the hot flue, still used in the padding style, p. 249. Currents of hot air have been tried, but are pronounced unsatisfactory, as the drying is found not sufficiently rapid. It is very probable, however, that this method of drying which is now applied with such success to a variety of agricultural produce might be so modified as to suit the requirements of the dyer and printer.

For many delicate colours, especially safflower, a current of dry air at common temperatures would be the most desirable drying agent.

The most common arrangement for drying is a series of iron steam chests, each having a surface of about 6 square feet. The pieces travel near, but not in actual contact with these chests. Steam drums, round which the pieces are made to pass, raise their temperature too high.

FINISHING.

Under this name are included a series of operations, the chief of which are starching and calendering.

The calender is a machine with revolving cylinders, between which the pieces pass, and are submitted to such pressure that their surfaces are smoothed and, to a certain extent, glazed. This process is used not merely for finished goods, but in preparing pieces for printing, especially for block-work, where a very heavy pressure is required, so as to give a perfectly smooth surface. After dyeing, as in alizarine and vat work, if steam, spirit, or pigment colours are to be blocked in, a second calendering is required.

The calender invented by M. C. Dollfus, and usually known as the Alsace machine, is one of the best known. It does double the work of the calender generally used in England, requires the attendance of a single workman only, and is not liable to accidents.

Paper cylinders or rollers are found very much superior to those of wood. They are not liable to split, crack, or warp, and they impart a much smoother polish.

Starches, differing considerably both in quantity and quality, are applied by means of an especial machine—the starching mangle. They are applied most plentifully to furniture prints, where the object is to produce a very glossy surface into which dust cannot penetrate. These starches, some of which approach to gums in their nature, are not generally prepared in print works, but are bought from the starch manufacturers.

“Breadthening” is a mechanical operation for restoring the cloths to their original width. In the various processes through which the pieces have passed, the pieces are found to have been pulled out in length, and, consequently, to have shrunk in width. The opening or spreading machine pulls them uniformly out to the extent of about 2 inches.

The machines and appliances for folding, pressing, and

packing the goods need the less notice here as these processes are not peculiar to dyed or printed goods.

DETECTION OF COLOURS UPON DYED AND PRINTED GOODS.

The recognition of colours upon the fibre is an important part of the dyer's and printer's duties. We give, therefore, the reactions of the ordinary dye wares.

I. REDS.

1. Boil with a solution of sulphate of alumina.

The liquor becomes tinged red, with a golden, green reflection: madder and alizarine colours.

a. It is tinged red, without the green reflection, and is decolourized on adding an equal volume of solution of the bisulphite of soda: the red woods, the aniline reds, coralline and safflower.

b. It is not decolourized, as above: cochineal, lac, and orchil.

2. Boil (in case of 1, *a*) with strong alcohol or methylated spirit.

The liquid turns red: aniline reds.

It is not coloured or scarcely perceptible: red woods, coralline and safflower.

3. Heat the goods with clear lime-water.

The lime-water is not coloured: safflower.

The lime-water is coloured red: red woods and coralline.

4. Heat the goods with dilute sulphuric acid.

a. The red on the fibre changes to an orange-red: the red woods.

b. The red on the fibre changes to a yellow, fading perceptibly: coralline.

5. Boil with strong alcohol (in case of 1, *b*).

a. The alcohol becomes coloured a distinct red: orchil.

b. It is not coloured, or only very slightly : cochineal, lac (kermes).

6. Heat with solution of baryta (in case of 5 b).

a. The liquid remains uncoloured : lac.

b. It takes a colour : cochineal (and kermes).

7. To distinguish the two latter, heat with lime water.

The red on the fibre turns brownish : kermes.

It turns violet : cochineal.

For a confirmation of the results given in the above table, the following experiments will be useful :—

1. *Madder and Alizarine Reds.*

These shades resist the action of reagents better than other reds. Place in four glasses the following liquids :—

Boiling soap-lye ;

Caustic ammonia ;

Lemon juice ;

A mixture of equal parts of tin crystals, muriatic acid, and water.

A swatch of the cloth (or a bit of yarn) is plunged into each of these.

If it remains unaffected in all, the red has been produced by alizarine, natural or artificial, anthrapurpurine, &c.

2. *Red Woods.*

The woods are much employed in imitating madder and cochineal shades. From the former they are distinguished by the reaction already given.

To distinguish the woods from cochineal, we steep a swatch in dilute sulphuric acid. If it turns a cherry red we have one of the red woods, and if it becomes a yellowish orange, cochineal. A solution of phosphoric acid turns wood-reds to a yellow, and decolorizes them, whilst it turns cochineal reds to an orange.

3. *Aniline Reds.*

These colours are slowly discharged by lime-water, bleached by sulphuret of ammonium, and restored to the original colour, or nearly so, by large quantities of water, especially if a trace of muriatic acid is added. Strong muriatic acid turns the red to a yellow, but on washing with abundance of water, it changes to a reddish purple. Soap-lye decolorizes the aniline reds, but on washing in pure water and passing into citric acid, the original shade returns, though fainter. The tin-salt mixture decolorizes aniline reds, turning them previously to a blue.

Eosine is immediately decolorized by collodion; whilst magenta, Magdala red, and alizarine dissolve in it without loss of colour. The behaviour of methyl-eosine is like that of ordinary eosine.

4. *Coralline.*

Coralline is not bleached by lime-water, which takes a pink tinge. If heated with chloride of copper it turns grey.

5. *Safflower (Carthamine.)*

This red is bleached by sulphuret of ammonium. Lime-water turns it yellow, without taking up any colour. On saturating the lime-water with acetic acid, the red shade returns. Soap-lye completely decolorizes safflower-red. On washing with plenty of water and moistening with lemon juice (citric acid), the red returns. The colour is met with chiefly upon silk, rarely upon cotton. On wool scarcely ever.

6. *Cochineal, Lac, and Kermes.*

Sulphate of alumina tinges itself a purple red with all three. Permuriate of iron darkens them all; dilute sulphuric acid turns them all to a yellowish-orange, except

in the case of the ammonical extract of cochineal, which is not reddened by the acid, but is coloured pink by phosphoric acid, which turns cochineal in its original state, lac, and kermes to a reddish-yellow. A mixture of muriatic acid and alcohol turns all three to a dirty yellow, which is converted into a crimson on washing in much water.

7. The weed colours, orchil, cudbear, &c., are completely decolorized by a solution of tin crystals.

II. YELLOWS.

1. Heat with alcohol or water, to which have been added a few drops of permuriate of iron (ferric chloride).

a. The colour of the goods alters very little or not at all: annatto, turmeric, aniline yellow, picric acid, naphthylamine yellow.

b. The colour of the goods becomes dark, yellow-green, olive-green, or black: fustic, fustet (young fustic), weld, bark, flavine, berries.

2. Moisten the cloth with oil of vitriol.

a. A blue or green spot: annatto.

b. A spot which becomes at once, or after a time, brown, brownish-red, or red: turmeric, aniline-yellow, picric acid, naphthylamine-yellow.

3. Pour on the goods a mixture of alcohol, muriatic acid, and boracic acid.

a. The liquor colours itself: turmeric, aniline yellow. The former gives a deep, and the latter a light pink. In case of turmeric the fibre as well as the liquid, on adding an equal measure of water, has a yellowish-red colour.

In case of aniline yellow the goods become coloured violet. On the addition of water the liquor takes a deeper colour, and the goods become crimson.

b. The liquor remains unaltered: picric acid, naphthylamine yellow.

4. Heat the goods with ammoniacal solution of copper,

and afterwards wash in water. If the colour on the fibre becomes bluish-green: picric acid. If olive green: naphthylamine yellow.

5. Boil with sulphate of alumina and add an equal volume of water. If the liquid is yellow, with a bluish-green reflection: fustic.

If yellow, without reflection: young fustic, weld, bark, flavine, berries.

6. Heat with baryta-water and lime-water.

a. The tissue dyes itself red: young fustic.

b. The tissue becomes only a little darker: weld, bark, flavine, berries.

7. Boil with glacial acetic acid. The liquid, when cold, shows:

a. A distinct green reflection, and a decided gold-yellow: flavine.

b. No reflection: weld, bark, berries.

8. Boil with solution of sugar of lead:

a. The colour of the cloth is unchanged: weld.

b. The colour turns to orange-brown: bark, berries.

The following remarks must be added. Picric acid is never found on cotton. It turns red if moistened with cyanide of potassium.

Iron buffs may often be found on cotton. If a swatch of the cloth is steeped in a warm, acidulated solution of prussiate of potash it is turned blue.

Chrome yellows and oranges, often found on cotton, are blacked by sulphuret of ammonium, and destroyed by caustic soda. Annatto resists bleaching liquor.

III. BLUES.

1. Steep a piece of the cloth in citric acid or lemon-juice.

a. The colour changes to an orange-red; logwood.

b. The colour gradually fades (more rapidly if moistened

with muriatic acid): ultramarine. Only met in printing, in pigment styles.

c. Colour unchanged: Prussian blue, aniline blues, indigo.

2. A swatch of the cloth is steeped in solution of chloride of lime.

a. Colour unaltered: Prussian blue.

b. Colour destroyed, or changed to a yellowish: aniline blue, indigo.

3. A swatch is steeped in caustic soda.

Colour unaltered: indigo.

Colour changed: aniline blue.

The following reactions may be of service:—

Aniline blues are extracted by steeping in alcohol, forming a blue liquid, not reddened by an acid. Soda lye turns them a reddish-brown, but on washing in plenty of water the blue is restored.

Prussian blues are turned a rusty brown by alkalies, but the blue is not restored on washing.

IV. GREENS.

All greens, except the aniline greens, lao-kao and chlorophyl—the two latter of which are not in practical use—are mixtures of blue and yellow.

1. Moisten with muriatic acid. The colour changes or disappears altogether, but is restored on washing in much water: aniline greens.

A swatch boiled in pure water turns to a dull violet: methyl-green.

2. Colour little affected by muriatic acid; destroyed or changed by alkalies. Little affected by mixture of tin crystals and muriatic acid: aniline blue and picric acid.

3. Alkalies destroy the blue; resists acids. Tin crystal mixture little action. The blue, but not the yellow, re-

stored by washing: aniline blue and a vegetable yellow. (N.B. The cases 2 and 3 are not rarely met with, and their discrimination is often difficult.)

4. Boil for a couple of minutes in alcohol at 95 per cent.

a. The alcohol turns yellow and the cloth more blue: the blue is then indigo or Prussian blue. When the yellow is all extracted, the cloth is steeped in bleaching liquor. If the colour is discharged it is indigo; if unaffected, it is Prussian blue.

b. The alcohol becomes green and the cloth grows paler, without altering its tone. Here we have an aniline green, or an aniline blue, topped as in cases 2 and 3.

5. Steep a swatch in carbonate of soda. If a blue colour dissolves out, the blue portion is extract of indigo. If, instead, a rusty shade appears, Prussian blue is present.

6. Expose the cloth, wet, to sulphuretted hydrogen. If it is blackened, and if the blue remains on carefully washing in a dilute acid, the yellow is a chrome-yellow (chrome of lead).

7. In case of printed goods (pigment styles), burn to ashes in a thin porcelain crucible.

a. The ash is green: a green oxide of chrome (Guignet's green).

b. The flame is green: the ash on being extracted with nitric acid and the solution freed from excess of acid by evaporation, and mixed with ammonia in excess, gives a blue liquid: Scheele's green, Paris green, or some other arsenical pigment. (The special tests for detecting arsenic in admixture with organic matter should here be applied. It must be remembered, that arsenic may be present in various colours, mordants, &c.)

V. VIOLETS OR PURPLES.

1. Steep in solution of bleaching liquor. If unaffected: alkanet. This colour is but little used.

2. Steep in sulphuret of ammonium.

a. The colour is discharged: blueish magentas.

b. Turns to a brownish-red: Perkin's violet, Hofmann's violet.

c. Little altered: orchil alone, or topping a vat-blue; wood violets alone, or along with a vat-blue alizarine purple.

3. To distinguish Hofmann's and Perkin's violets: pour cold dilute muriatic acid upon the cloth. The liquid turns yellowish, and the cloth greenish: Hofmann's violet.

The liquid turns violet, and the cloth is scarcely altered: Perkin's violet.

4. Boil with alcohol.

a. The liquid turns pink or brownish-yellow, and is coloured violet by ammonia: orchil.

b. The alcohol is scarcely coloured: madder (alizarine) purple; the wood violets alone, or with logwood.

N.B. Orchil is completely destroyed by a mixture of tin crystals and muriatic acid.

5. To distinguish madder purple from cochineal purple: steep in chloride of lime.

a. The cloth turns to a yellow: madder.

b. The colour is discharged: cochineal.

N.B. As both madder and cochineal purples have an iron base, the swatch, after steeping in chloride of lime and washing, is moistened with an acidulated solution of yellow prussiate. If a blue colour is produced, the original dye was a madder or cochineal shade. If no blue appears, it was orchil or logwood.

6. Burn a little of the cloth to ashes in a porcelain capsule.

a. Nothing remains: aniline violet.

b. White ash remains: logwood, with a mordant of alumina.

c. Red ash remains: madder or logwood, with a mordant of iron.

7. Pigment purples may be treated with weak muriatic acid. If the blue shade disappears, and a red remains, unaffected by acids: ultramarine and vermilion.

If the colour is totally destroyed: violet ultramarine.

VI. BLACKS.

1. Colour resists all re-agents. The ash, after burning white: lamp-black, or some other form of finely-divided carbon. This colour occurs only in pigment styles, and if diluted with albumen and gum to a sufficient extent, gives the fastest greys.

2. Strong muriatic acid produces no immediate change; but, on standing, the cloth becomes greenish, and the liquid turns an olive-brown. Tin crystals and muriatic acid give a green, turning to a grey. The colour is restored by ammonia, but not by water: aniline black.

3. Apply solution of chloride of lime.

a. The cloth turns a chestnut brown, which is not turned blue by an acidulated solution of yellow prussiate of potash: chrome black.

b. Cloth turns yellowish, converted to a blue by yellow prussiate: logwood black, gall black.

To distinguish these, apply dilute muriatic acid. If a cherry-red spot is produced, immediately we have a logwood black with an iron mordant. If logwood and iron are dyed on a vatted ground, dilute muriatic acid gives in a few minutes a dull purple spot. A mixture of muriatic and oxalic acid gives a red liquor, and turns the cloth blue, *i.e.*, leaves the indigo untouched.

It is not easy to give any definite directions for the examination of browns, "modes," olives, &c., on account of their complexity.

APPENDIX.

Bleaching and Printing Jute.

Mr. C. F. Cross (Patent, No. 4984, A.D. 1880) bleaches jute and similar fibres as follows: He treats the yarns, &c., in an open vessel, with solutions of the neutral sulphite of soda, containing from 1 to 2 per cent. of sulphurous acid as sulphite, and he then boils in a kier at a pressure of 5 lbs. to 15 lbs. per square inch in a similar solution.

In printing bleached goods, such as jute or hemp, the goods are well washed, mangled to remove water, and taken through a solution of bisulphite of soda, containing about 2 per cent. of combined sulphurous acid. The pieces are again mangled or drained in the centrifugal, and returned to the bisulphite bath, and allowed to lie for a few hours. It is then dried, printed as usual, and may then be steamed for the development and fixation of the colour without injury.

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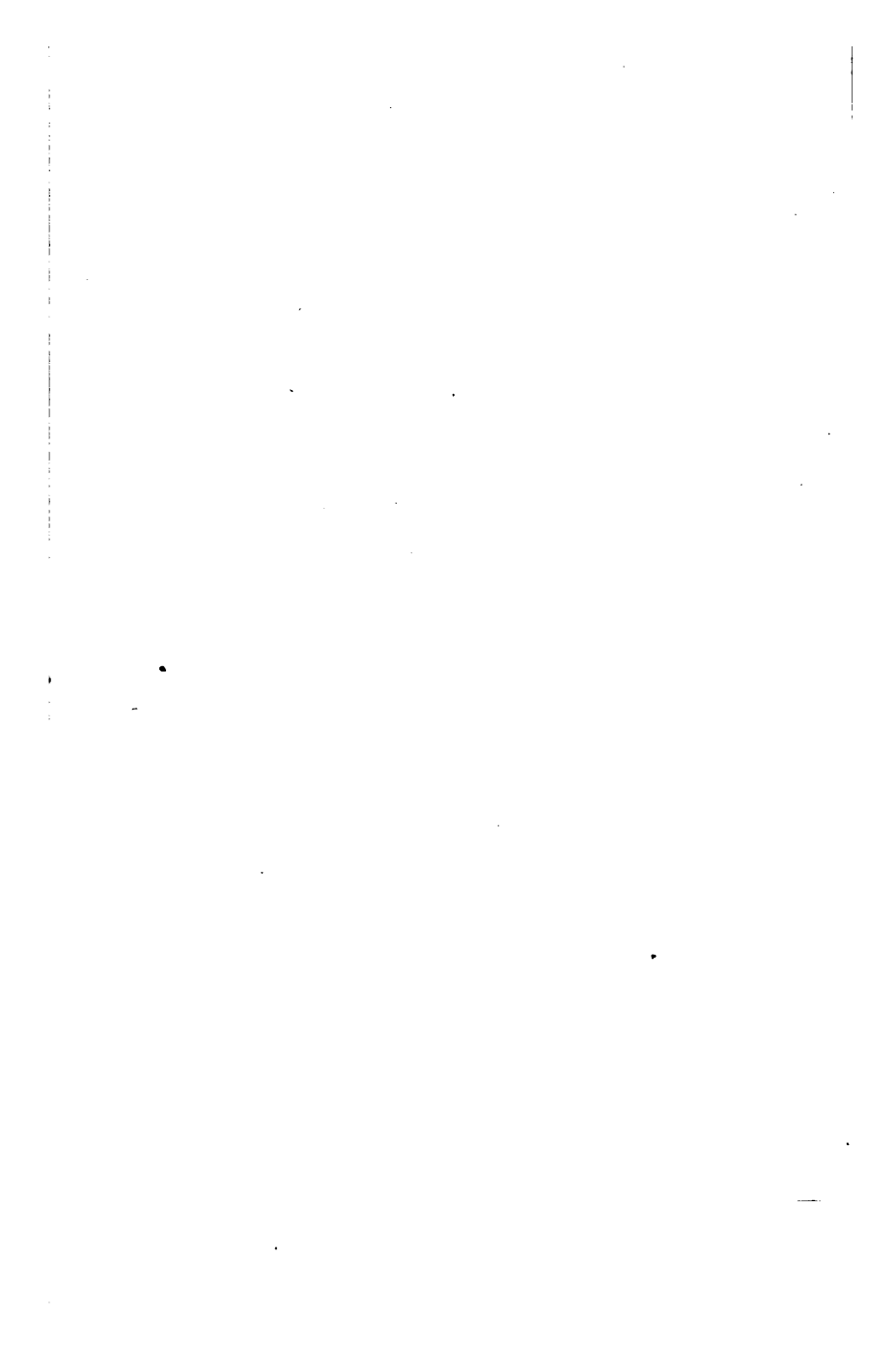
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